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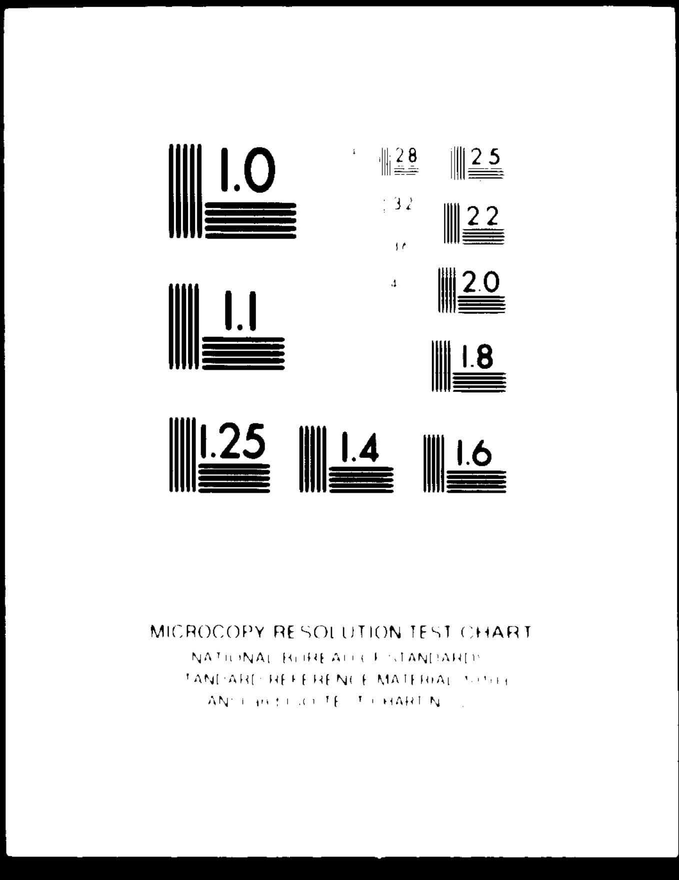

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REPORT

ON

AROMA CARDBOARD FACTORY

(EASTERN SUDAN)

04399

Prepared

for

THE UNITED NATIONS

By

Dr. Julius Grant

M.Sc., F.R.I.C

1968

107, Fenchurch Street,
London, E.C.3.
England.

January, 1968.
Ref. 27689X.

REPORT ON

AROMA CARDBOARD FACTORY

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PART I

INTRODUCTION

In accordance with a special Service Agreement dated 31st August, 1967, Ref. SUD-692-SI, between the Undersigned and The United Nations, I visited the Republic of the Sudan during the period 14th November to 5th December, 1967, inclusive. The following were my terms of reference as set out in the above Agreement and in the course of correspondence referring thereto. "The expert will be expected to carry out a detailed survey and investigation into the operational performance of a cardboard manufacturing factory. Subsequently, he will be required to submit a report and recommendations for bringing into effect overall levels of operating efficiency and product quality compar ble to accepted commercial standards in this industry".

The following background information was supplied. "The Ministry of Industry of the Republic of the Sudan, through the Industrial Development Corporation, owns and operates a cardboard factory at Aroma, Eastern Sudan. The factory commenced production in January, 1963, with a projected capacity of 4,000 tons of cardboard per annum on a continuous 3-shift per day basis. The factory is using as its basic raw materials, cotton stalks and wheat straw.

Problems have arisen whereby it has not been possible to achieve the projected output and the quality is far below the standard required for commercial marketing. These problems stem mainly from deficiencies in the standard of raw materials used, its handling and transportation, and technical processing difficulties affecting the standard of quality of the product".

<u>Travel Programme.</u>		This was as follows:-
Tues. 14th Nov.	-	Departure from London.
Wed. 15th Nov.	-	Arrival at Khartoum - U.N.D.P. Headquarters - Sudan Industrial Research Institute (S.I.R.I.).
Thur. 16th Nov.	-	U.N.D.P. - The Packaging House Ltd., - National Paper Industries Ltd., - Blue Nile Packaging Co. Ltd., - S.I.R.I.
Sat. 18th Nov.	-	S.I.R.I. - U.N.D.P. - Ministry of Industry & Mining - Industrial Development Corporation - Botany Dept., University of Khartoum.
Sun. 19th Nov.	-	S.I.R.I. - Abdou-Diab - Tahamine Sae - E.S. Mina - Hassein Derdiri.
Mon. 20th Nov.	-	S.I.R.I. - Taha Hassan - Kamal Mohamed - Ministry of Works - National Building Research Institute - Printing House Ltd., - Arabian Trading Co. Ltd.
Tues. 21st Nov.	-	Khartoum to Kassala - Onion-Drying Factory - Kassala to Aroma - Aroma Cardboard Factory.
Wed. 22nd Nov.	-	Aroma Cardboard Factory.
Thur. 23rd Nov.	-	Aroma Cardboard Factory - Gash Agricultural Corporation Board.
Frid. 24th Nov.	-	Aroma Cardboard Factory.
Sat. 25th Nov.	-	Aroma Cardboard Factory.
Sun. 26th Nov.	-	Aroma Cardboard Factory.
Mon. 27th Nov.	-	Aroma Cardboard Factory.
Tues. 28th Nov.	-	Aroma Cardboard Factory. Aroma to Kassala. Kassala to Khartoum.

Wed 29th Nov.	Khartoum, S.I.R.I. Stores & Equipment Dept.
Thur 30th Nov.	U.N.D.P., S.I.R.I., National Paper Industries Ltd.
Frid 1st Dec.	Khartoum to Barakat
Sat 2nd Dec	Sudan Gezira Board, Barakat to Khartoum.
Sun 3rd Dec.	Khartoum, S.I.R.I., Misr Printing Co. Ltd., Government Printing Press
Mon 4th Dec.	S.I.R.I., U.N.D.P.
Tues 5th Dec	Khartoum to London.

Personal Contacts.

In the course of my work I received the utmost co-operation and courtesy from everyone with whom I came into contact. I particularly wish to put on record my appreciation of help given to me by:

Abdalla Abdel Wahab, Under Secretary, Ministry of Industry and Mining.

H. W. Kamberg, Resident Representative, United Nations Development Programme, Khartoum

Gely Hamed, Managing Director, Industrial Development Corporation

Dr. M.H. El Haltawi, Director, Sudan Industrial Research Institute (S.I.R.I.).

Valued assistance was also obtained from the following, who are listed in the chronological order of meeting them:

H. J. W. Smith, Production Engineer, Sudan Industrial Research Institute (S.I.R.I.).

D. I. [illegible], Assistant Resident Representative Admin., United Nations Development Programme, Khartoum

Mrs Turnbull, Secretary, S I R I.

Salamabi, General Manager, The Packaging

House, Ltd , Khartoum.

Tosh, Works Manager, The Packaging House Ltd

Al Sir, Director Blue Nile Packaging Co Ltd ,

Khartoum

J Salteris, Production Manager, Blue Nile Packaging

Co , Ltd

G Marek, Chemical Engineer S I R I

Hassan Abdel Rahman, Engineer, S I R I

M Rassa, Professor of Botany, University of Khartoum

Abdou Diab, Suitcase Factory, Khartoum

Tahamine Sac, Handbag Factory, Khartoum

E. S Mims, Match Factory, Khartoum

Hussein Derdiri, Paper Merchant, Omdurman

Taha Hassan, Suitcase Factory, Khartoum

Kamal Mohamed, Bag Factory, Khartoum

Kamal Satei National Building Research Institute

Mohamed el Hakim, Engineer, S I R I

Ayoub Gerish, Sales Manager, Printing House Ltd ,

Khartoum

Arabian Trading Co , Khartoum

Hashim Mohamed Osman Ministry of Works

Mamoun El Fadel, General Manager Aroma

Cardboard Factory.

Hamid El Khidir, Works Manager, Aroma Cardboard

Factory

Bukhari M. Bukhari, Manager, Onion Drying Factory, Kassala.

Issedin Mirie, Manager, Gash Agricultural Cooperation Board.

P. Russell, Agricultural Economist, Sir Alexander Gibb, & Partners.

Sayed Ahmed El Magid, Controller, Stores & Equipment Dept., Khartoum.

A. Nicola, Managing Director, National Paper Industries, Ltd., Khartoum.

A. John, Director, National Paper Industries, Ltd., Khartoum.

Tageldir Mohamed, Engineer, Industrial Bank, Khartoum.

Shamam Omer, Economist, Industrial Bank, Khartoum.

El Nur Mohammed Nurel Huda, General Manager, Sudan Gezira Board, Barakat.

Hussein Omer Kisha, Mechanical Engineering Dept., Sudan Gezira Board.

B.P. Pothecary, Agriculture Economic Advisor, Sudan Gezira Board, Barakat.

Mohd. Ibrahim Ahmed, Research Institute, Sudan Gezira Board, Barakat.

Abdel Ghani, Misr Printing Co., Ltd., Khartoum.

Mahmoud El Fadli, Government Printer, Khartoum.

Mohamed Khogali, Managing Director, Blue Nile Packaging Co., Ltd.

W. Aitken, Managing Director, Imperial Chemical Industries (S). Ltd., Khartoum.

Messrs. G. Marsh and Hassan Abdel Rahman accompanied me to Aroma and to Barakat, and their assistance on these occasions is greatly appreciated.

Plan of this Report.

The Report is compiled under the following headings.

Part I - Introduction.

Part II - Background and History of the Aroma Cardboard Factory.

Part III - The Present Position.

(a) Raw Materials.

(b) Description of the Factory and Processes.

(c) The Product and its Markets.

(d) Production Cost.

Part IV - Recommendations.

(a) Short Term.

(b) Long Term.

(c) Production Cost and Profitability

Part V - Summary of Conclusions and Recommendations.

Part VI - Appendix. National Paper Industries, Ltd.

Notes

The following points should be noted in regard to this Report.

1. Unless otherwise stated, all quantities are in metric units, and values are in Sudanese pounds and milliemes.

£. 1.000 = U.S. $. 2.87

1 feddan = 1.038 acre = 4,200 sq. m.

2. The term "per day", means 24 hours.

3. Part V is intended to be read independently of the remainder of the Report. It contains all the essential features of the latter, but without the supporting details.

4. The Appendix to the Report (Part VI), deals with the mill belonging to National Paper Industries Ltd., in Khartoum. This short study was included at the request of the Sudan Industrial Research Institute and the Industrial Bank. As will be seen, it is a matter of some importance in its own right, but the significance in the present connection arises from the fact that it could be a potential competitor of the Aroma Cardboard Factory if the recommendations made are put into effect; or, it could become a customer for pulp made at Aroma. These aspects are discussed further in the text of the Report.

PART II

BACKGROUND AND HISTORY OF THE AROMA CARDBOARD FACTORY

The background and history of this project have been pieced together, so far as it has been possible, from records in the files of the Industrial Development Corporation, the factory itself at Aroma, and the Sudan Industrial Research Institute.

The stages of the history can be set out chronologically as follows

1[illegible]th July, 1959

Invest Import who were commissioned by the Yugoslavian Government to carry out the work, provided a complete specification and costing. The estimated yield of pulp from cotton stalks was 1 ton of board from 1,400 to 1,500 kgm. of cotton stalks, i.e., 70% assuming dry basis. The electricity requirements were estimated at 300 kw. per ton, and heating was based on the use of coal. A milk of lime process was suggested for the digestion stage, and there was no provision for the use of waste paper. Under these conditions a production cost of £ 35 per ton, and a selling price of £ 73 per ton, ex factory, were forecast.

Subsequent forecast operating requirements were (per ton of board produced) :-

Cotton stalks	:	1.82 tons
Waste paper	:	0.15 ton
Caustic soda	:	0.128 ton
Digestion	:	130-180°C.
Fuel oil	:	0.24 ton
Water	:	65 cu. metres
Electrical power	:	735 kwhr.
Labour	:	135 persons
Management	:	14 persons

18th July, 1959.

An Agreement was signed between the Government of the Republic of the Sudan and the Federal People's Republic of Yugoslavia, concerning the building of a cardboard factory at Aroma in Eastern Sudan under a Yugoslav Credit Agreement. The capacity of the factory was to be 4,000 tons per annum assuming a 3 shift working day, and cotton stalks and wheat straw were the proposed raw materials. In accordance with this Agreement, 10 to 15 tons of cotton stalks were to be supplied for experiments in Yugoslavia; the trial and takeover were envisaged for July to October, 1961.

As to the quality of the product, this was to be equal to a sample of board prepared in Yugoslavia from the above-mentioned cotton stalks.

According to the Agreement, the factory would be taken over by the Government of the Sudan when "plant capacity is such as to make possible an output of 4,000 tons per annum of cardboard . . . . , and the quality of the cardboard produced is in compliance with the samples to be prepared by the Seller" (from rawstock samples sent).

The estimated cost was £ 312,530, of which 1% was to be paid on signature of the Agreement, 9% on erection of the plant and the remaining 90% by means of an 8- to 10 year credit at 5% interest.

In actual fact, the total cost (excluding working capital) was £ 480,023, made up as follows:

Civil engineering	£.96,321
Power house building	26,158
Stores	7,140
Staff houses (rent free)	47,079
* Project engineering	12,000
* Steel structures	44,667
* Plant and machinery	134,053
* Erection and running in	51,810
Diesel sets and electrical	57,130
experts	3,665
	£ 480,013

The asterisked items are those mentioned in the Contract and total £ 242,530 in value.

1st March, 1961

... Import produced a specification which was intended to form part of the Contract. However, it differs from the final specification eventually issued (see below).

January, 1963

The factory started up, under a Sudanese Manager with several Yugoslavian technicians.

April, 1963

Report from the Japan Consulting Institute. The primary object was a basic survey for a paper industry in the Sudan, but the Report refers to a visit to the cardboard factory for one day. Most of the Report is concerned with the use of papyrus in a mill making 30 tons of papers per day in the first instance, in the Malakal or Kosti area. The comment on the Aroma factory was that it is "simple and primitive" and about "pilot scale" in magnitude.

9th January, 1964

A [illegible] report was handed to the Government Industries [illegible] by their engineers Messrs. M. Rajevic and A. Pavlovic [illegible] Aroma. They comment that only 1 shift is working instead of 2 as formerly.

[illegible] January, 1964

[illegible] letter to [illegible] report from [illegible] Shaddad, Manager, Government Industries Board. It is pointed out that the production cost of the cardboard exceeds £.180 per ton, and that difficulty [illegible] selling it for £.40 per ton.

[illegible] February, 1964

A report was made by M. Rajevic and A. Pavlovic to Sayed [illegible] Shaker [illegible] General Manager, on a trial run lasting 9 days, with 10 working hours per day, using 4 or 5 of the installed machines. [illegible] worked 365 machine hours and produced 49 4[illegible]0 kgm [illegible] board, equivalent to 550 kgm. per hour [illegible] the 5 machines, or 135 kgm. per hour per machine. The [illegible] 80 hours and dried 44 000 kgm [illegible] per hour.

13th March, 1964

Report of a Committee set up by the Sudan Government Industries Board to investigate conditions in the factory and to organise takeover trials.

In connection with the former, it was pointed out there was no proper measurement of raw materials; the methods of removing sheets of board from the machines was crude; pressing was also crude; there was no dryer control; calendering was ineffective; weighing and testing were inaccurate; there were inadequate instruments and some of these were not working. There was also excessive load on the diesel generator, which hunted when on full load; and there was no standby. General design was poor, and there was no protection of electric cables from water.

The takeover trial was specified for the 13th March, 1964, and the Committee set out the various quantities and grades of board which should be produced in specific times.

Undated

Mr Rajovic, on behalf of the Yugoslavians, objected to the Committee's requests as "unreasonable" and, after some acrimony, the Committee was disbanded.

1st December, 1964.

Invest-Export informed the Government Industries Board that the factory was not in a suitable condition for takeover trial, and stated that the Sudan Government had in fact accepted the factory by reason of managing it. Invest-Export would meet their obligations though on an ex gratia basis. The Sudan Government would have to pay for the Yugoslav technicians, and there were vague threats of arbitration.

4th December, 1964.

Report from Ingenieurburo, Robert Hoesch, Düren. This made certain recommendations such as the use of a higher temperature in the digesters, and beating to obtain a longer fibre length, and it criticised the breast box design as giving rise to thickness variations. There were also comments on the impurities in the final board. At this time apparently, 2-stage digestion operation was being tried, e.g., 2 hours at 100°C., followed by 3 hours at 120°C.

9th February, 1965.

Letter from Mr. Shaddad to Invest-Import, disputing their letter of 1st December, 1964, and repudiating it. There is reference to the fact that the board samples made in Yugoslavia contained wood pulp.

Spring 1965 (?)

Offer of assistance from Parsons & Whittemore, Inc., New York, through Abushamma Agency & Trading Co.

8th April, 1965.

Letter from A.M. Sadig, Ministry of Works, Kassala, to the General Manager of the cardboard factory, commenting on the effect of caustic soda in causing cracks in the digester discharge pit.

30th April, 1965.

Correspondence with the Tropical Products Institute, London, extending to 5th August, 1965. It was pointed out that the freeness of the stock is an important factor, that millboard made by the procedure used is always brittle in character, and that a multi-vat process is better for boxboard. The blowing troubles noted (see Part III, b) were attributed to drying.

29th June, 1965.

Report by C.G.H. Govier, who estimated that the cost of production was £.145 per ton, and the production 2-tons per day. Up to 35% of cement sacks were being used, and there were possibilities of a shortage of cotton stalks in the future. This applied also to the waste paper cement sacks hitherto obtained from the dam workings at Khashm el Girba. With this in view, stocks of cotton stalks were being accumulated. It was recommended that the mill should manufacture particle board and plaster board.

29th October, 1965.

A letter from the Industrial Development Corporation (A. Hamid) to the cardboard factory, pointing out that prices obtainable for the board ranged from £.45 to £.55 per ton, according to colour. Kraft liner prices were £.157.500, fluting £. 54.150, and chipboard boxes £. 67.5 per ton, c.i.f. Khartoum.

April, 19[illegible].

B. The [illegible] (United Nations) reported troubles in running the plant and in marketing the board. These he attributed to keeping the raw materials in stock too long, and to the drastic caustic soda cook. In this latter connection he suggested pre-treatment with lime in pits. He also advocated using the cement sacks as received, i.e., without a digestion stage. The use of hide powder in the beater was recommended for sizing the board.

[illegible] subsequently visited the United States and in particular the Northern Regional Research Laboratory at Peoria, Ill., the U.S. Forest Products Laboratory at Madison, Wisconsin, and the Institute of Paper Chemistry, Appleton, Wisconsin. Various suggestions were received such as pre-treatment with lime, and the blowing troubles were attributed to over-treatment in cooking and in beating. It was thought that the Mechano-Chemical process might possibly be an improvement on an ordinary pressure cook, and that the cold soda process might also be tried.

[illegible]ber, 19[illegible]7.

The last two remaining Yugoslav technicians left the factory [illegible] that the [illegible]

[illegible] the $4\frac{1}{2}$ years of its active [illegible] and that a number of explanations [illegible] and [illegible] them contradictory [illegible] fact [illegible] succeeded in obtaining [illegible] 4,000 [illegible] 40 [illegible] have only a very [illegible]

[illegible]

[illegible]

[illegible] and [illegible]

Volumes 2 and 3 (in the Industrial Development Corporation files) - deal with civil engineering work, water supply, sewage, and electricity.

Volume 4 (in the Industrial Development Corporation files) - gives details of the process and plant, with drawings. From the present point of view therefore it is by far the most important volume. It may be summarised briefly as follows.

Tests on the cotton stalks were made by the laboratory of the Priedor factory, in Yugoslavia. It was pointed out that the material is very heterogeneous, and that to obtain the best use from it, it should be classified, i.e., presumably different treatment given to different parts of the plant. This is technically sound, but of doubtful economic feasibility; it was not put into practice in the specification evolved for the mill.

Semi-industrial tests led to the following data and proposed working details:-

Yield:	50%
Sand and dust	12%
Pulp	48%
Working period	300 days per annum
Shifts	3 per day
Output	13.3 tons per hour
Cotton stalks	24.4 tons per day
Used papers	2 tons per day
Storage capacity (outside)	1,000 tons cotton stalks
Stack capacity	350 tons
Distance apart of stacks	40 metres
Covered storage capacity	24 hours
Size of cut stalks	25 to 35 mm.
Capacity of cutters	1.5 to 2.0 tons per hour

Digestion	
Digester capacity	22 cubic metres - 2.6 tons pulp?
Time cycle	4 per day.
Caustic soda	8% on cotton stalks
Fibres to liquor ratio	1 to 4, after steam addition
Liquor	7,000 litres (added in 2 stages)
Time cycle	6 hours
Pressure	8 to 10 atm
Refiner consistency	3%
Sand trap consistency	1.0 to 0.5%
Machine capacity	900 kgm. per 8 hour shift
Number of machines	
Single vats	4
Double vat	1
Presses	200 tons, 300 atm.
Moisture content after presses	55%
Moisture content after drying tunnel	8 to 10%
Sheet size	1,000 x 700 mm.
Weight (10% moisture)	15 to 60 sheets per 25 kgm.
Calenders	15 to 20 metres per min. (30 tons)
Broke treatment	by pulper
Steam consumption (per kgm. board)	1.29 kg. steam at 170-180°C. and 8-10 atm
Dryer	1.78 kgm. steam
Total	3.07 kgm. per kgm. board
Boiler	2 to 3 tons per hour - 962 tons oil per annum.
Water (from Kassala)	
4 wells	67,000 litres per hour per well.
2 wells	22,500 litres per hour per well
Total	81 litres per sec.
Mill requirements total	18 litres per sec.
	120,000 litres per ton of board.
Payroll:	
Direct labour	137
Administration	14
Total	151

Practical tests on a semi-industrial scale gave a product "similar to grey card board" using 8% caustic soda for digestion and 15% of kraft paper from used cement sacks. This was stated to be suitable for "boxes, common registers (folders?), book covers etc"., but the colour was light brown, and small [illegible] were observed. Quality was [illegible].

but it was stated, the board should not be used in direct contact with food. A wide field of use was envisaged in view of experience in Yugoslavia, but no market study appears to have been made in the Sudan.

The board samples prepared in Yugoslavia to be used as a standard of quality for the products of the factory, were seen at the premises of the Industrial Development Corporation. This was before my visit to the Aroma factory and I did not then appreciate the tremendous difference in general quality between these samples and the Aroma factory product. I confined my examination to a microscopical evaluation of one of the samples which was said to consist of 100% cotton stalks, and my examination showed this to be correct. The other samples were described as containing various amounts of longer fibred material, and it would have been of interest to have ascertained the proportions of used papers and of wood pulp present. The appearance of the samples certainly confirmed the presence of better-grade materials.

If these experimental boards are to be used to provide a working specification of the quality which the mill product has to reach, then numerical evaluations should be carried out as follows:

Basis weight

Caliper (and thence, apparent specific gravity).

Rigidity.

Folding strength.

Scoring capacity.

Folding strength.

Bursting strength.

Surface properties.

[illegible]

Actually the samples remaining are far too small to enable all the above tests to be carried out. By careful working however, and by utilisation of most of the samples, it should be possible to set up an approximate working numerical specification.

PART III

THE PRESENT POSITION

The present position as regards manufacture in the Aroma Cardboard Factory, is discussed below under the following 4 headings: -

(a) Raw Materials.

(b) Description of the Factory and Processes.

(c) The Product and its Markets.

(d) Production Control and Management.

(a) Raw Materials

Criteria of Fibrous Raw Materials for Paper and Board.

It is as well to consider at this stage what is required of fibrous raw material for the manufacture of paper and board; the term paper is included, because this is involved in the recommendations made in this Report (Part IV). Theoretically, any material containing fibrous cellulose (i.e., any vegetable plant) can be used for the manufacture of pulp for paper and board. The value of any one particular plant species for the production of pulp depends however, on the following considerations.

Technical.

1. Ease with which the non-fibrous constituents (e.g., pith, wood, resins, etc., as the case may be) can be removed.

2. Colour-to-strength ratio. The strength is reduced as colour is improved by processing, and vice versa; it is desirable to obtain the optimum balance between the two for each kind of pulp.

3. Suitability for the purpose in question.

4. Suitability for treatment at an economic figure.

5. Yield of cellulose.

6. General cleanliness.

__Economic Considerations.__

1. Quantities available; waste materials having no other use are preferable.

2. Ease of harvesting or collection.

3. Transport facilities and costs. Many suggested raw materials which satisfy the other considerations have proved uneconomical for this reason.

4. Regularity of supplies, both as regards quality and quantity.

5. Cost of processing, including chemicals, and steam and power, and with this is bound up the purpose which the pulp is required. A pulp having exceptional properties can sometimes command an exceptional price, so that the cost of production is a minor consideration.

6. Ease with which supplies may be replaced. Thus annuals are better than perennials from this point of view, and plants which take a long time to reproduce themselves, (such as trees) are at a disadvantage in this respect at any rate.

It is safe to say that, on the whole, wood fulfils these requirements, taken together, to a greater extent than any other plant material. Supplies are plentiful; they can be replaced when exhausted, although time is required; and a variety of processes has been involved, enabling wood to be converted into pulps suitable for most present-day requirements. Moreover these processes have been the subject of close scientific study and control over many years, so that regularity of output and quality are ensured. Other plant fibres fulfil many of these requirements to a greater or less degree, and among these are certain possibilities which are worthy of exploration so far as the Aroma Factory is concerned.

__Cotton Stalks__

As already stated, the factory was built to use the cotton stalks remaining after harvesting of the cotton, and it was located in Aroma principally because this is conveniently placed for the cotton plantations of the Gash Agricultural Cooperation Board.

It is important to realise that (so far as I know) cotton stalks are not yet used commercially for paper or board manufacture anywhere in the world. A certain amount of experimental work has been carried out on the laboratory scale e.g., in the Northern Regional Research Laboratory at Peoria, Illinois, in India, and by myself for the Sudan Gezira Board in 1950 (see Part IV). The general conclusion reached was that cotton stalks can be used to produce a coarse wrapping paper or even, after bleaching, a low grade of printing, when processed as the whole plant. Separate treatment of the long fibres however, was found (in my experiments) to give a fairly strong brown wrapping paper, but the yield was low. On the whole, cotton stalks compared unfavourably with other more readily available fibrous raw materials; this is the reason why their use has not made headway in world pulp production, despite the fact that they exist in abundance and are usually available for the [illegible] collection in cotton-growing countries. Existing experimental work on cotton stalks has been approached from a paper making rather than a board making point of view, but it is safe to say that what applies to the former applies with even greater force to the latter. With heavy boards in particular, the short fibres and high hemicellulose content in the unbleached state will tend to produce a rigid and brittle product.

It should also be noted that cotton stalks from different localities often behave differently as a raw material for paper or board manufacture. This is understandable, since cotton itself varies in quality according to species and locality. There are certainly differences in these respects between cotton stalks from the United States and from the Sudan, and even between stalks from the Gezira and Aroma areas.

In view of the uncertainties attached to cotton stalks as a fibrous raw material for board manufacture, a thorough preliminary investigation of its properties should have been made as part of a Feasibility Study for the present project. As shown in Part II, the information at my disposal contains no record of such a study. A quantity of 10 to 15 tons was apparently, sent to Yugoslavia for semi-commercial trials, but the only result was a booklet of small pieces of board, one of which was made wholly from cotton stalks and the others from mixtures of cotton stalks and waste papers or wood pulp. The board resulting from the tests (using [illegible] caustic soda and 85% used kraft cement sacks) is described as "similar to grey cardboard" and [illegible]; light brown in colour, containing tiny particles, but could be [illegible]. Not suitable for direct contact with food, but the field of use could be extended by the inclusion of imported Yugoslavian pulp.

So far as I am aware, no account is given of the experimental procedures by which these samples were made, and it seems safe to state that, whatever these were, they differed materially from the manufacturing details specified and for which the mill was ultimately constructed. It should be pointed out, in parenthesis, that if economics are left out of consideration, it is possible to obtain experimentally products of reasonably good quality from almost any fibrous raw material, and certainly from cotton stalks. Moreover no tests appear to have been carried out on the beating properties and best refining conditions for the pulp, or on the essential physical characteristics of the boards produced. The sheets in the sample booklet are far too small to enable the latter to be carried out.

It is stated in Volume 4 of the specification that the tests on the cotton stalks were carried out by the laboratories of the Prieder factory in Yugoslavia and that the stalks were found to be heterogeneous and had to be classified ([illegible] sorted). The yield obtained was said to be 66% after removal of 32% of wood and dust, which is equivalent to 40% yield on the bone-dry, whole original [illegible]. This appears to be reasonably in accord with subsequent experience (see Mill Trial, Table 1). However, in a letter from Invest-Import dated 11th July, 1959, there occurs an estimated yield of 65 to 70%; this of course, may refer to the dust-free cotton stalks, but this is not clear. So far as I know, there are no records of yield experiments carried out under practical factory working conditions, and indeed there appear to have been no proper facilities for or attempts at making such tests in the factory as at present conducted. During my visit, such an attempt was made; 4 tons of raw cotton stalks were used with 400 kgm. of old, used cement sacks, and these yielded 1.992 tons of board (gross) see Table 1.

The practical usage of the cotton stalks has been complicated and bedevilled by other factors. In the early days of operation of the mill, large purchases of cotton stalks were made in advance of actual requirements; this was of course, done quite correctly in order to provide a stock of raw material for the initial and future running of the factory. In view of local conditions, one year's supply must be purchased at the time of harvesting the cotton stalks in the early part of the year. As it happened, the mill used only a fraction of its estimated annual requirement, which presumably, would be about 8,000 tons per annum (in order to make 4,000 tons per annum of board). A large surplus of cotton stalks has therefore, been built up during approximately 3 years, and the last of this was being used at the time of my visit.

Table 1

MILL TRIAL

Cotton stalks	3,600 kgm.
Caustic soda	330 kgm.
Water	7,200 litres
Pressure	4 atm.
Time	3 hr.
Waste papers	400 kgm
Production (gross)	
No. 18 (heavy)	860 kgm
No. 40 (medium)	650 kgm.
No. 90 (thin)	175 kgm
Total	1,685 kgm.
Waste	307 kgm.
Total	1,992 kgm.
Yield	95%

Notes

1. The yield figure is based on the ratio of gross board made (including substandard board, trimmings and wet and dry waste after the board machines) to raw materials used, assuming 50% yield for cotton stalks and 75% for waste papers. The figure of 95% shows that these are reasonable assumptions.

2. Since an endeavour was made to manufacture 3 thicknesses of board from pulp beaten to the same wetness, the proportions of substandard paper for the Nos. 18 and 40 grades were high; it was low for the No. 90 grade, because the wetness was appropriate. As explained in the Report, complete control of wetness was not possible.

3. All weights of materials and board are assumed to be dry basis, but a check was not possible.

4. The cotton stalks were from the 1967 harvest, and had been in store for about 8 months.

it was obviously in a very bad state of attack by bacteria and insects, with the result that the fibrous characteristics had severely deteriorated, and much of the plant substance had been converted into dust inside the outer cortex of the stalks. The de-dusting equipment installed in the mill was not capable of removing this high proportion of dust, with the result that much dust was passing into the digesters as well as into the air, with consequent waste of cooking chemicals and objectionable working conditions; it was even apparent in the final board. Both the yield and quality of the board were therefore, affected seriously. The trial referred to above (Table 1), made during my visit, used cotton stalks from the 1967 harvest and therefore, only about 8 months old, and a marked improvement in the quality of the pulp made was apparent. However, at present the stocks of cotton stalks will last only about 3 months, even at the present rate of usage.

As regards price, it is understood that a premium has been paid to the farmers for the cotton stalks above the actual cost of collecting from the field, and that these items plus the cost of transport resulted in a delivered price of £ 2.890 per ton. The moisture content of the stalks at the time of purchase is unknown, but presumably it is normally very low and the stalks dry out to a bone-dry state. Since the stalks were transported in the loose state, advantages which could more than offset the extra cost involved might be achieved by baling. This point is developed later in this Report.

A final stage in the unfortunate history of cotton stalk usage is the announcement by the Gash Board that it is proposing to reduce, and eventually to cease, planting cotton on any scale in its area. Although the cotton from this area is high in quality, the yields are low due to inadequate irrigation; the land is fertile, but water is available only for 3 months of the year. The whole position is accentuated by the low price of cotton. Castor seed (from Ricinus communis) is regarded as more profitable, and large areas of healthy-looking plantations were seen during my visit. The local Manager of the Gash Board did however, state that he is prepared to recommend that about 1,000 feddans should be kept under cotton to assist the Aroma Cardboard Factory. However, this area would yield only approximately 750 tons of cotton stalks per annum, an amount far inadequate for the mill's requirements. In any case the position would be extremely precarious from the mill's point of view, especially as a change in management of the Gash Board is shortly to take place, and this possibly could result in a change of policy.

Cotton stalks exist in considerable quantity in the area between the Blue Nile and White Nile controlled by the Sudan Gezira Board. However, the cost of transporting these to Aroma would be prohibitive, and in any case the policy of the Board is to burn the stalks in the field to prevent the spread of insect-induced diseases.

One is therefore, forced reluctantly to the conclusion that any plans for the future of the Aroma Cardboard Factory must be based on a fibrous raw material other than cotton stalks, quite apart from the fact that cotton stalks are not a very suitable material for the manufacture of the types of board being made.

Castor Plant (Ricinus communis).

This is a logical first choice, since its future availability in the Gash area should be approximately the same as that of cotton stalks in the past. Castor is of course grown for its seed and the oil extracted therefrom, and it is the stalks left in the field which would be used for papermaking purposes. Here again, however, as with cotton stalks, there is no past experience either from laboratory or full scale working, to serve as a guide to the suitability of castor stalks; although a Brasilian worker has claimed that they are satisfactory for fine papers.

According to the present Manager, the Gash Board is prepared to allocate the stalks from 20,000 feddans of land near the mill on the northerly side, as a source of supply of the stalks. If one assumes the same yield per feddan for castor stalks as for cotton stalks (and this may be optimistic in view of the tubular character of the former), this area would give approximately 15,000 tons of stalks per annum (dry basis), which is far greater than the cardboard factory's requirement of 8,000 tons. Since apparently, the land to be allocated for this purpose is not required for other purposes, it might be possible to grow the castor stalks primarily for stalk rather than for the seed. In other words, a variety might be developed which gives a high yield of stalk at the expense of the seed, though some seed of course would be obtainable. This is a problem for the geneticist, and it is understood that Ahmed Mutwakil, of the Hudeiba Research Station, Ed Damer, might have some information in this connection. It is however, most important to ascertain whether the castor plant grown in the Gash area is an annual or perennial. The latter is the more usual, and of course, the amount of stalk obtainable from it would be very much less on a sustained yield annual basis.

The harvesting of the castor seed normally starts towards the end of December and continues for approximately 4 months. There are usually two pickings, the second when the less ripe seeds have matured, so that all the stalks would not be available until approximately April. It is possible that the harvesting of the stalks could be mechanised.

It is understood that with cotton stalk purchases a premium was paid over the actual cost of cutting. If a fresh start is made with the castor stalks under the conditions suggested above, the stalks should be purchased on a direct cost basis. This should present no difficulty as a similar system is at present in use in Sudan for harvesting sugar cane. In this event an approximate cost per ton might be reached as follows, assuming that the sales value of the seed at least pays for the planting cost plus the farmer's profit on the seed.

Cutting and transporting to roadside.	£. 0.500
Baling	£. 1.000
Transport	£. 0.250
Delivered cost	£. 1.750 per ton
Add for contingencies and moisture, say	£. 0.25
Total delivered cost	£. 2.000

The transport cost is calculated on the basis of a 5-ton lorry, taking a 4-ton load of baled stalks 10 km. distance, for £ 1.000.

The delivered cost estimated above is approximately 65% of the present cost of cotton stalks, which are transported loose, whereas the castor stalks would be baled. [illegible] would have to be given to the type of baler used, because it is evident that an ordinary hay or straw baler would not be satisfactory. A heavy-duty type of baler is required, and these are available to handle at least 2 tons per hour, with two operatives. The above baling cost therefore, does not seem unduly optimistic.

Everything therefore, depends on the papermaking qualities of the castor stalks. These would need to be evaluated thoroughly as soon as the stalks are available in March-April, 1968, in the laboratory in the first instance. Empirical large-scale tests can also be carried out simultaneously in the Aroma Cardboard Factory in order to save time; the present procedure and cooking conditions as used for cotton stalks could serve as a starting point. The laboratory experiments should however, be relied upon to provide data for the operating conditions (such as chemical concentration, time and temperature) which give the best results. They should also yield sufficient data to enable the yield and the paper and board making properties of the pulp to be assessed thoroughly.

This therefore, is the next and very vital stage in the raw material situation at this mill. If it is achieved successfully, then a most important step towards the rehabilitation of the Aroma factory will have been taken.

Kenaf (Hibiscus cannabinus).

This plant is known to be an excellent papermaking fibre, and experimental plantations exist at Khashm el Girba, [illegible] 140 km. distant from Aroma by railway. However, kenaf is also a textile fibre, and its use in a low-grade cardboard is unlikely to be economic, unless it could be delivered at a suitably low price. However, factory waste may be available eventually, and at a reasonable delivered cost. Alternatively the stalks, as distinct from the fibre, may be usable. It is understood that approximately 5 tons of such stalks are being sent to the Aroma factory for a preliminary experimental trial. It should however, be remembered that kenaf is not yet established as a permanent and self-sustaining crop in any quantity at the present time, whereas the needs of the cardboard factory are quantitatively large and very urgent.

As this plant may possibly become an important source of raw material for paper or board manufacture in the Sudan, a few general notes concerning it are desirable in this Report. A good deal of sporadic work has been carried out on it in various parts of the world, but without great success, the limitations being mainly economic. Of recent years these studies have been intensified in the United States. In that country the plant grows like a weed, and indeed can compete successfully with weeds. It is nevertheless susceptible to bacteria, which attack the roots, and commercial fungicides (as used for cotton seed) were found to be effective. Yields are of the order of 6 tons per acre and the plants reach 10 to 11 feet at maturity, but the stage of growth at the time of harvesting appears to be important.

The kenaf may be harvested with the type of machinery used for forage and can be stored outside (in the U.S.) for 18 months without apparent harm. It is proposed that, for papermaking purposes, the whole kenaf stem should be utilised, since the use of the bast portion alone (which makes up 20% of the total stem) is unlikely to be economic. On the other hand the bast fibres are suitable as a substitute for long-fibred pulp, whereas the woody constituents are short-fibred and offer no advantage over other agricultural fibres. Kenaf is similar to cotton stalks in that if the stems are utilised in the whole state, the net result is a pulp with low initial freeness and a brittle character. These are the qualities which have led to the difficulties and complaints in the case of the cotton stalks used at the Aroma factory. A bleached grade is obtainable; yield 40-48%.

To sum up, kenaf could be a promising material where the cost of processing the long-fibred portions separately could be balanced by the low price of the kenaf and the high price of the product produced from it.

Durra (Sorghum vulgare)

This is now grown plentifully in the Gash Board area, and some very healthy crops were seen. However, the stalks are said to be used as cattle food and otherwise on the farm, (despite the fact that the stalks and leaves of [illegible] S. vulgare are poisonous to cattle), and are likely [illegible] expensive. Nevertheless, the possibility of being able to purchase some surplus should be explored, as Sorghum straw is known to be a good raw material for papermaking.

Local Bush

A local bush grows abundantly around Aroma. It was not possible to ascertain its name for certain. A quantity of such bush [illegible] have been collected, and were at the mill [illegible] in readiness for full scale trials. If these [illegible] promising, then the question of economics will [illegible] study because the bush is bulky but light, and [illegible] over wide areas; collection [illegible]. Also it is unlikely that it will [illegible], and almost certainly not [illegible] years. While present supplies [illegible] bridge [illegible] gap for the mill, it is unlikely that it can be depended upon as a raw material on a long term basis.

[illegible]

[illegible] at [illegible] per ton, delivered [illegible]

[illegible] material [illegible]

[illegible] unately [illegible]

[illegible]

Bagasse (Sugar-cane waste)

There is a sugar mill at Khashm el Girba, and bagasse is known to be a satisfactory raw material for the manufacture of paper and board of certain kinds. However, the economics of its use are bound up closely with the cost of a fuel to replace it for raising steam in the sugar factory. The economics of this substitution are individual to each sugar mill, and need to be worked out by a study on the spot. It seems unlikely that the bagasse could be sold at a price which would make it economical for delivery at Aroma for use in a low-grade cardboard.

Used Papers

The original scheme developed for the Aroma Cardboard Factory envisaged the use of a proportion of used papers containing long-fibred wood pulps. These were to be added to the cotton stalk pulp in the proportion of 20%, in order to make the cardobard. When the dam at Khashm el Girba was being built, used cement sacks were available in large quantities and were purchased by the Aroma Cardboard Factory at the very low price of £.8 per ton, delivered. Even in their used state and containing cement residues these were without doubt an excellent raw material, being composed of long-fibred, kraft coniferous wood pulp, which is the best of its kind from a strength point of view. Unfortunately, it was an error to use only approximately 20% of the cement sacks with the cotton stalks as specified, since in view of the low production of the mill over the past 3 years, this meant that most of the cement sacks have remained unused for this period. They are stored in the open and as a result of the successive heat, sunlight and to some extent rain, have so deteriorated in strength as to be virtually useless to contribute any strength; they are in fact, now little more than a filler fibre. If they had been used in the proportion of say, 80%, with cotton stalks, while they were new, then the cardboard factory could undoubtedly have had a profitable run while the supply lasted, since both output and quality would have been improved.

The sacks do not have to be digested (although this was being done at the mill quite wrongly, at one time), and they require otherwise very little preparation for the manufacture of board. It seems highly probable that, under these conditions, the mill could have made board of the quality and quantity originally specified at a production cost of approximately £.30 per ton. This state of affairs could not have lasted, but it would have helped the factory to weather the subsequent unprofitable period, which the deteriorated cement sacks now being used merely accentuate.

At the present reduced rate of production, sufficient cement sacks remain in stock to last for about 1 year; but as stated, their board making value is low. The prospect of further supplies of this class of material, or indeed of any waste paper, seems remote. The main centre of supply is Khartoum, where there are already outlets in the two (and perhaps later, 3) mills who can use such materials (see Part III, c, and Appendix). There may be supplies in

Port Sudan, which is nearer to Aroma, but the amount is unlikely to be large, the cost of transport would be high, and the quality very mixed.

Conclusion

The fibrous raw material outlook is very unpromising. [illegible] application of a scientific approach to the study of the castor stalks will enable these to be used in time to bridge the gap after the supply of cotton stalks is exhausted. The implications of a failure to do so are set out under the recommendations in Part IV.

(b) Description of the Factory and Processes

In the following description and discussion of the factory and processes, each department will be dealt with in sequence and special attention will be given to the following points:- Factory and process as at present operating; points of departure from original specification; comments and recommendations.

Handling and Cutting of Raw Materials

Fig. 1 is a flow sheet covering operations at this stage.

As already stated, the present main raw material is cotton stalks, and they were bought at the time of the harvest in sufficient quantity for the mill's estimated requirements for the following year. They are purchased by area, i.e., at a price of £. 2.890 per feddan, which is said to be equivalent to £. 3.053 per ton; this assumes a yield of about 750 kgm. per feddan. However, the present stock now stands on the books at £.2.890 per ton delivered, and this figure is used in the production cost calculations given in Part III d. So far as can be ascertained, the above figure is made up as follows: -

Collecting costs	£.0.500 per ton
Transport (assuming 1 ton per 5-ton lorry, costing £.2.500 per journey)	£.2.500
Profit for farmer	£.0.850
Total delivered cost	£.3.850

Even though the cotton stalks dry out rapidly in the sun and they are bought by area, it is necessary to know the true weight of dry material purchased and thence, the price per ton paid. Thus the cotton stalks may have some moisture content in the wet season. Moisture tests are therefore highly desirable. The stalks are transported loose by lorry and as they are bulky and light, only about 1 ton can be loaded on to a 5-ton lorry. This means that transport is costly. For this and other reasons, the baling of the stalks is desirable, and this is discussed further below.

The stalks are stored loose in a large walled compound approximately 170 x 100 metres in dimensions to the north of the mill. There is an exit through the wall at the mill end, and there is a light railway consisting of two lines crossing at a turn-table in the centre of the stocking area. The lines thus run parallel to the walls, and at the time of my visit, were short of the specified length by approximately 50 metres, towards one of the walls.

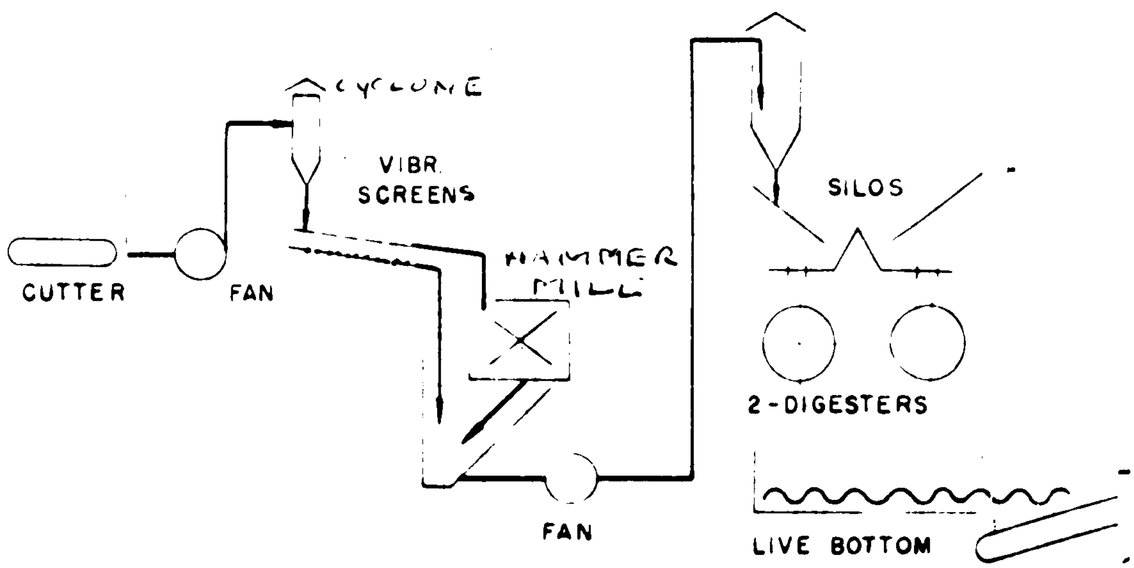


Fig. 1

PROCESS: CUTTING TO DIGESTION

The cotton stalks are moved on flat, hand-pushed bogeys with loose boards across them to provide a wider area of carriage. The fire risk is considerable, the only precautions in the storage area being numerous buckets of water and sand; all the former and most of the latter were empty during my visit. Dry cotton stalks are highly inflammable and the prevailing northerly wind at the time of my visit could readily carry sparks from a fire over the wall or through the gap at the mill end, to the day's supply of loose stalks which is normally kept at the entrance to the cutter house in the factory itself. A trailer pump is available for fire-fighting purposes, but would be of little use under these circumstances. Baling would enable the stalks to be stacked neatly, with adequate fire-break spaces, and it would also protect them to some extent from insect attack during storage (see Recommendations, Part IV). Transport of the cotton stalks from the stacks to the mill would be facilitated, since the bogeys could be more easily handled and more heavily loaded.

The stalks are brought into the open end of the cutter shed, as required, in order to feed the cutter. With a 24-hour day working period, enough for 24 hours should be brought in during the day shift. However, if the stalks were unbaled they would occupy such a huge space that double handling would be involved. However, this situation has not yet arisen, as at most only two shifts per day have been worked. Under present conditions, with the 06.00 to 14.00 hours shift only working, no special problem arises.

The stalks are fed to the cutter, without weighing. It being assumed that when a digester is full it contains 4 tons. Baling would enable the actual weights used to be controlled. The cutter is of the type used for straw, and is followed by a fan and cyclone which extract some of the dust and discharge it through a chimney to the open air. The cut material then passes over 2 superimposed vibrating wire screens, and more dust is removed through the meshes of the 2 wires and collected in bags. The small and medium sized pieces of stalk are passed by the coarse screen and retained by the fine screen, and pass forward through a blower and cyclone to the digester storage silo. The material retained on the coarse screen passes through a hammer-mill, and thence via the same system, to the storage silo.

One defect of this system is that the fine screen becomes rapidly blocked by the dust and, at the beginning of my visit, only about 35% of its area was usable for this reason. Frequent cleaning is necessary. Also there appears to be no means of preventing the oversized pieces which pass the hammer-mill unaffected, from accompanying the accepted pieces to the silo. The presence of fibre lumps in the final cardboard suggests that this is in fact, taking place.

In order to test the capacity of the above system, during my visit, 4 tons of the 1967-harvest cotton stalks were weighed out and passed through it. The operation was completed in 2 hr. 50 min., with 2 men working on the cutters and 3 men serving them; a supervisor was also present. An electricity failure lasting for 15 minutes was excluded from the trial, but two blockages (one in the cutter and one in the cyclone which together lost 25 min. [illegible] in the operating period given above. As the men started at the beginning of the day's work, they were fresh (and they were also being watched) so that 3.5 hours for dealing with 4 tons is probably a more realistic figure.

The results showed that the system is easily capable [illegible] approximately 30 tons [illegible] in 24 hours. It was noted that towards the end of the period of the trial, the rate of feeding the cutters slowed down considerably, as the two men concerned had to walk longer distances as the accumulation of stalks in the immediate vicinity of the cutter [illegible]. The amount of loose stalks that each [illegible] was quite small. This further [illegible] feeding the stalks.

[illegible] in the bags was weighed and [illegible] 7.5% of the whole cotton stalks used. [illegible], if the dust lost to the atmosphere through the system is included the total dust removed was probably [illegible]. Under full production conditions this could [illegible] approximately [illegible] tons per year, and a use [illegible]. The relatively fresh stalks [illegible] and the dust content of the old cotton stalks [illegible] than this.

[illegible] this trial was used to fill one digester, and the [illegible] was subsequently kept separate and [illegible] the mill trial referred to elsewhere [illegible].

Digestion Process (Fig. 1).

The cut and screened stalks are blown to the top floor of the digester house, where they fall into a hopper silo over the digester filling floor, which is capable of holding sufficient stalks for 4 digestions (2 in each digester). The object of this is to accumulate sufficient stalks for 24 hours of working during the daytime. The digesters are 22 cubic metres in capacity, and it is being assumed that when full each contains 4 tons of dry stalks. However, in the trial run mentioned above (Table 1), the production from 4 weighed tons of cotton stalks by no means filled the digester. With the old, very dusty, cotton stalks in current use the digester when completely full probably contained much more than 4 tons of material, although its fibre content would be relatively low. According to the specification, a milk of lime cook should have been used, and a lime slaker and classifier were supplied and were seen stored in the factory. At some time, apparently, it was decided to use caustic soda instead. I feel that this was a wise step, not so much because caustic soda is a more suitable chemical in the present instance than lime (indeed, the reverse is probably the case), but because the plant as installed is more suitable for use with caustic soda than with milk of lime.

The chemical treatment is carried out by dissolving a 340-kgm. drum of solid caustic soda in a tank at ground level, and pumping the contents up to a high-level tank, which is used to fill the digester. There is also a water tank at the high level The two high-level tanks have working level indicators, but the indicator for the ground-level tank is broken. No chemical test of the strength of the caustic soda solution is made at any stage, and moreover the caustic soda has been in stock for some 3 years and may have deteriorated in quality. Consequently the calculation on which the amount of caustic soda actually added to the digester is based must be extremely approximate, and indeed subject to great error since the true weight of stalks in the digester is not known. Under these circumstances it is of course impossible to conduct cooks which are best suited to the raw materials; or even uniform cooks.

A caustic soda content of 8% on the original dry weight of the stalks was aimed at during my visit (i.e., 330 kgm.), and water was added to make 8,000 litres.

After the digester lids have been bolted down, steam is admitted through the trunnions at 4 atm. pressure. However, the pressure gauge in the external steam-line recorded only 3.5 atm. A thermometer is fitted to the lid of each digester, but neither was working at the time of my visit, and the air inside the digester was not being released before starting the cook. For the above reasons it was quite impossible to control (or even to know) the temperature at which digestion was being carried out. The rate of rotation of the digesters was 55 seconds, which is somewhat fast, but this is not believed to be a critical factor.

The time-cycle used at present is as follows (in hours): -

Filling	1.0
Raising to pressure	1.5
On pressure	3.0
Emptying	0.5
Total	6.0

In the trial digestion carried out with a weighed 4 tons of cotton stalks, the cycle used was as follows (hours):

Filling	1.0
Venting air	0.5
Raising to pressure	1.5
On pressure	2.5
Emptying	0.5
Total	6.0

The caustic soda content was 8% of the solid contents of the digester (3.6 tons) representing an estimated economy of 112 kgm. per digestion (subject to the inaccuracies of the method used for estimating the caustic soda content).

At the end of the pressure cook, water is added to partly cool the contents of the digester, and the charge is emptied under pressure into one of a pair of pits, each having a live bottom. There is no means of recovering heat from the blow-off steam; and the used black liquor is allowed to run to waste in the effluent (see below). No means are available for measuring the residual caustic alkalinity in the black liquor, and a further serious handicap is the fact that there is no means of obtaining a sample of the cooked stalks before the digester is emptied. This means that a raw cook cannot be rectified [illegible] a re-cook; and the pit [illegible] be emptied to [illegible] with resulting loss of production and of material.

The lower portions of the pits are conical with square end-sections, leading to a base provided with a pair of central screw conveyors and two parallel similar outer conveyors. Between the conveyors are perforated slots to drain away the waste black liquor to the effluent. The screw conveyors are intended to carry the pulp out of the base of the pit to a conveyor belt. In practice however, the design of the pit is such that much pulp lodges in the pit bottoms, and in particular on ledges above the conical base and so out of reach of the screw conveyors. This means that the pulp has to be washed down with a high-pressure water hose, a lengthy and inefficient procedure which has to be completed by a man entering the pits and shovelling the pulp into the screw conveyors. This is a dangerous practice.

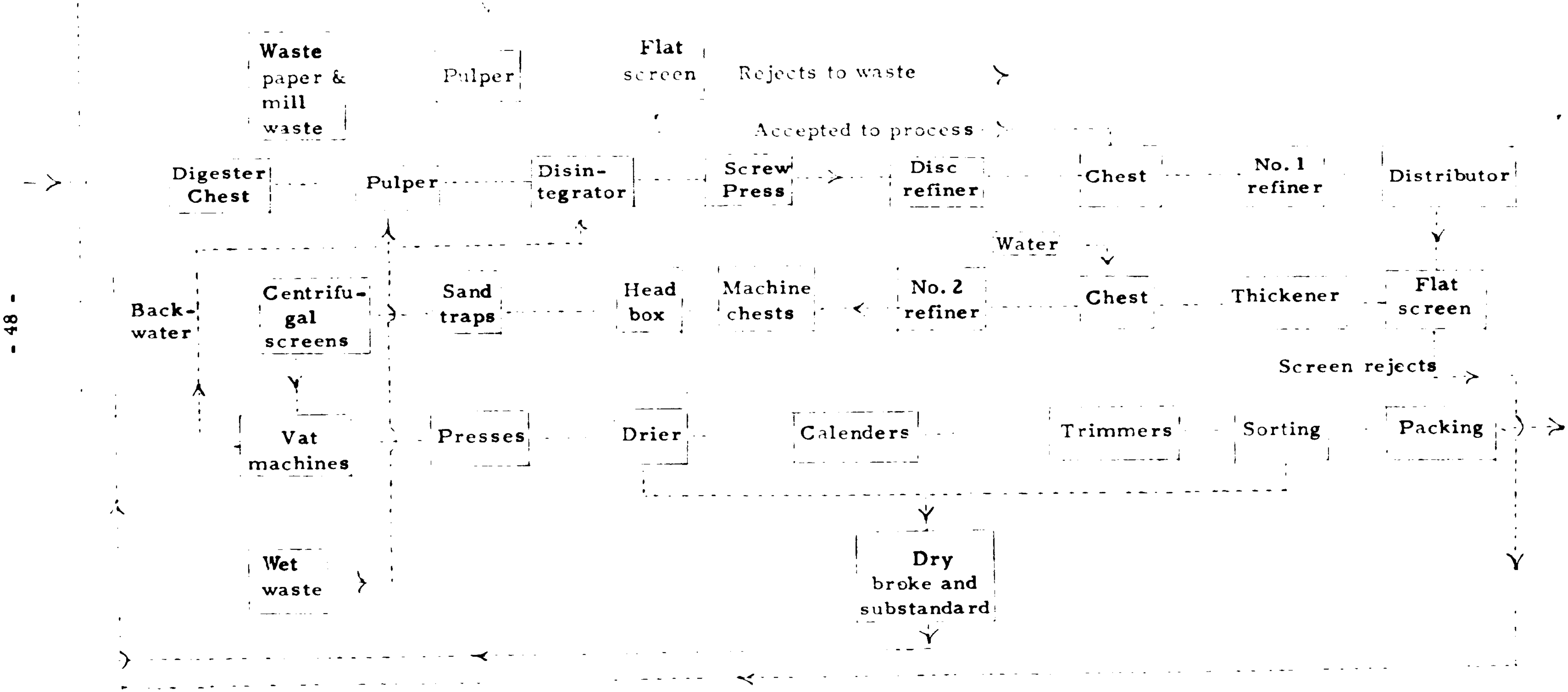
The correspondence on the factory refers to trouble with the pits at an early stage, apparently due to the walls cracking.

Stock Preparation

The operations comprising this stage are shown in Fig. 2. A conveyor belt (Fig. 1) takes the pulp, with its remaining associated black liquor, to a disintegrator with revolving arms. This breaks up the lumps of pulp and passes them (mixed with back-water from the board machines, see below) to a screw press. This removes most of the liquor. No means are available for ascertaining the moisture content or sodium content of the resulting pulp. The pressed pulp then passes through

Fig. 2.

FLOW SHEET - BOARD MILL



a disc refiner with one stationary and one rotating disc, and thence to the first storage chest where pulp from the used papers (see below) is added. From here the mixed pulp passes through No. 1 refiner to a distributor and thence to a Jensson type shaking screen. The rejects from the screen are returned so that they pass through the disc refiner again; and the accepted pulp is thickened, and sent to the second storage chest where water is added prior to the pulp passing through the second (No. 2) refiner. The pulp is then ready for the board machines feeding chests.

Used cement sacks or sub-standard millboards are pulped separately in a mechanical type pulper, with the aid of steam, and the resulting pulp is diluted and passed through a shaking screen. The rejects are sent to waste, and the accepted pulp is added to the pulp from the cotton stalks in the first storage chest. Normally 200 kgm. of cement sacks (as received) are used for every 1 ton of cotton stalks (dry basis) processed.

Normally this pulp preparation stage of the operation would be controlled by means of wetness (Schopper Riegler) measurements and consistency tests, taken before and after each refining stage and the screening stage. The function of the wetness test is to measure the ease with which the pulp parts with its water by drainage, since this property decreases with increasing degrees of refining of the pulp. This is a very important value from the point of view of the formation of the board on the machines subsequently. The consistency figure gives the percentage of dry pulp in relation to the amount of water present, and it also is important because the efficiency of the screening and refining operations depends on this property.

In practice, none of these tests could be made at the time of my visit, because the laboratory weighing balance on which they depend was not accurate and required expert attention to make it so. Adequate provision for these tests was however, provided with the original equipment. A Schopper Riegler instrument for wetness tests is reliable only when the consistency of the pulp tested is known. I found that the effect of this variable was being ignored, so that such tests as were being made were meaningless. By using an approximate method based on experience, it was possible during the mill trial to establish that the disc refiner was effective in raising the wetness in terms of Schopper Riegler, but that the Nos. 1 and 2 refiners were producing very little effect of this nature. It is understood that this is due to excessive wear on the bars. In the trial, great difficulty was experienced in raising the Schopper Riegler from 22 to 30 degrees during the whole of the pulp preparation operation.

The Board Machines and Presses

As Figs. 2 and 3 show, pulp from the No. 2 refiner passes to the first of the machine chests supplying the 5 board machines and then, after dilution, it passes over sand traps. From this stage the whole system is duplicated, so as to serve either Nos. 4 and 5 machines from one unit, and Nos. 3, 2 and 1 machines from the other unit; No. 1 is a double machine.

with 2 vats. The sand traps are very short and consequently, of very little value for dirt removal. This shortcoming was aggravated at the time of my arrival by the absence of the baffles from the bottoms of the traps. These were subsequently replaced, but the bottoms of certain of the traps were warped, so that the baffles did not fit properly and dirt could pass underneath them. After the sand-traps are centrifugal screens (one per machine), and these should be much more effective in removing the lighter dirt. Then follows the actual board machines.

According to the specification, 1.3% of resin and also sodium silicate should be added to the pulp for sizing. This was not being done at the time of my visit.

As stated, there are 5 board making machines (Fig. 3) Nos. 2 to 5 inclusive, are conventional vat millboard machines. No. 1 however, has two vats, although at the time of my visit only one was in operation. I was told that difficulties were experienced when both vats were being used. The pulp is deposited as a wet mat in web form on the wire-covered, hollow cylinder (A) rotating in the vat. After this it is couched (A) on an endless felt, and removed from the felt on to a metal roll having a deep groove parallel its face (B). The wire of the cylinder has a raised edge around the middle of its periphery, and this produces a thin place in the centre of the wet web as it is formed.

When the requisite number of layers (depending on the basis weight of the board being made) has built up on the metal roll (B), the composite layers of pulp are cut longitudinally by running a knife along the groove. Two men can then peel off

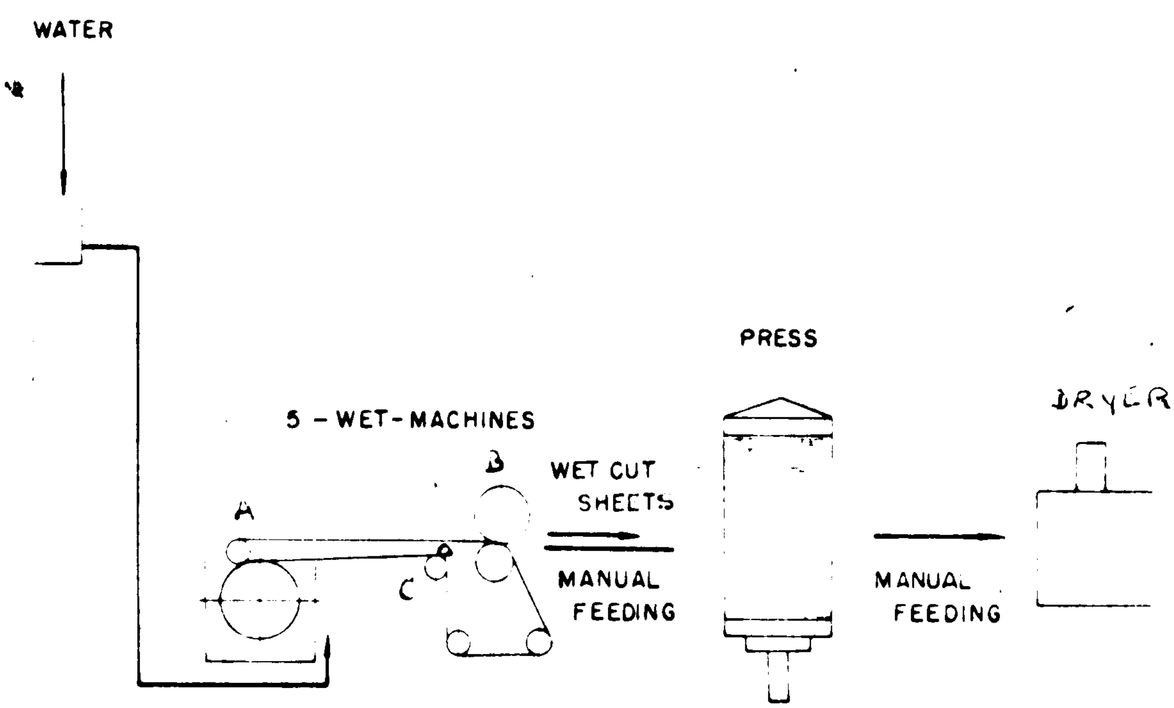


Fig. 3

VAT MACHINES - PRESS - DRYER

the 4 thick sheets so produced (because the area of the face of the metal roll is divided centrally both laterally and longitudinally). A wheel device rides on the edge of the web on the metal roll, and when the thickness for which it has been set is reached, then it rings a bell warning the men to strip the roll. The total area of the forming roll face is approximately 100 cm., in the machine-direction (i.e., circumference) and 140 cm.. in the cross-direction (i.e., machine width). Splitting therefore, gives 4 sheets, each 100 x 70 cm., in dimensions, the long edge being in the machine direction.

This is the classical method of making what is commonly known as millboard, and the machines in the Arema factory are simple and rather crude examples of this type. Thus they are capable of forming a continuous web, but the absence of proper adjustments means that it is difficult to obtain boards of uniform weight and thickness. Thus, there is no consistency regulator for the pulp entering the vat; the pressure of the couching roll (A) on the forming cylinder cannot be adjusted accurately along its length, and lateral adjustment is impossible; and there are no felt conditioners, apart from a small press (C) to squeeze out excess moisture. In consequence, and also probably because of the high dust content of the material used, the felts (which are very costly) have to be discarded after about 40 days when they are fully stretched; a life of 60 to 80 days is normal. The thickness-indicating device on the metal roll is not satisfactory; not only is it crude, but it does not always receive an immediate response from the men working on the machine. It was noted that occasionally one or even two extra layers were formed on the roll before the sheets were removed by the men. A relatively thin board (No. 90 Grade) should normally consist of 5 layers; medium board (No. 40 Grade) 11 layers; and heavy board (No. 18 Grade), 23 layers. The Grade 18 type of board takes several minutes to build up on the roll, and it was noted that with such boards especially, action in stripping the roll was not always punctually observed. A light would probably be preferable to the rather faint bell at present installed, as it would also be visible to the foreman.

The 4 single and 1 double vats together are specified to make a total of 800 kgm. of board per hour at a speed of 10 to 25 metres per minute. However, the practical maximum speed during actual operation appears to be only 21 metres per minute, although the drive is capable of running the machine when it is not making pulp at up to 30 metres per minute. The figure of 800 kgm. per hour is equivalent to over 19 tons per day, which should be well in excess of the mill's rated capacity of approximately 13.5 tons per day (i.e., 4,000 tons per annum for 300 working days), even if allowances are made for starting-up, shutting-down and contingencies. The mill trial indicated that this output should be possible if a fairly large proportion of heavy-weight boards were made, but not if much light-weights were being made. The trial also established that a single sheet of approximately 75 grams per square metre could be made and couched, but that this was too thin to be taken off the forming roll by hand in the wet state. It was however, possible to remove a 2-layer sheet (156 gm. per sq. m.) with ease, and some sheets of this nature were taken for testing purposes and the results are given in Part IV.

Customer complaints (see Part III, 2) which might arise from the board machines rather than from the cotton stalks, were non-uniformity of thickness and weight both between various sheets and also various parts of the same sheet. Possible reasons for these defects have already been dealt with above. However, a very serious defect which is apparent on the cylinder and which renders necessary the repulping of a considerable proportion of the board made, is a "bubbly" effect between the layers, which is accentuated by drying and results in local delamination of the board. This occurs only with the thickest types of board (No. 10 Grade) and it occurs mainly below the last one or two layers to be formed on the forming roll (B). It would appear to be partly inherent in the use of cotton stalks, but it is largely due to the inadequate beating which was a characteristic of the mill trial. This again emphasises the importance of wetness control and effective refining, so that the wetness appropriate to the weight of board being made may be achieved before the pulp goes to the vat machines.

The trouble is of course, common to all five machines, and is particularly serious because the heavy boards are the best selling lines made by the mill. Another important consideration which arises from this is the fact that since there is only one stock preparation plant, all 5 machines have to make a similar type and weight of board at approximately the same time. There is no provision for preparing pulp stocks suitable for thin and thick boards to be made at the same time, unless the two machine chests are filled completely with pulps of different wetness, and used separately; this would be inconvenient. Many of the present making troubles arise from improperly-prepared pulp, lack of adjustments on the machines, and lack of flexibility in using them.

In my view it is also undesirable to attempt to make the thick 23-layer boards (No. 18 Grade) on the single-vat machines. I believe that the double-vat machine (No. 6) was intended for this particular purpose. There should be perseverance in making it work properly.

A minor problem being experienced during my visit was an excess of froth in the vats, which was affecting the surface of the board. Considerable quantities of water were being used for showers in the vats but not very effectively, and markings and unevenness of the surfaces of the board were apparent. It was not possible to establish the true cause owing to lack of experimental facilities. However, it was believed to be due to the high alkalinity in the vat, arising from the residual caustic soda and the inadequate washing of the pulp provided by the whole process. Alum to the extent of at least 1% on the weight of pulp was therefore, added to the machine chest in order to reduce the alkalinity, and this effected a marked improvement. The procedure suggested in the Recommendations (Part IV), should help to reduce this surplus of caustic soda with benefit to the suppression of froth, as well as contributing to economy of chemicals and a better effluent.

The sheets removed from the rolls of the board machines are stacked into wads on metal sheets, are interleaved at intervals with hessian cloth, and then pressed hydraulically, there being one press to each machine (Fig. 3). The presses operate at 200 to 400 atm. according to the thickness of the sheets being pressed, and the time in the press is at present a matter of personal judgment; the danger is in premature removal from the press, rather than the reverse. The proper operation of the press, namely the pressure and time on pressure, should be based on the moisture content of the pressed wads, but no facilities exist at present for making this important control determination. It was in fact evident that, even to the touch, sheets leaving the presses varied considerably in moisture content; this of course affects their final properties.

Drying

The dryer consists of a tunnel approximately 24 metres long, 3.2 metres wide overall, and 2.5 metres high. Into this individual sheets (70 x 100 cm.) are fed, four abreast; the total operating width therefore, is just under 3 metres. Provision is made for drying the sheets by means of heat and air, and there are 7 dial thermometers along the length of the dryer indicating the internal operating temperatures. It should be added that the sheets of board are carried between 2 endless moving coarse wires, which hold them in their passage through the dryer. Successful drying in a machine of this nature depends very largely on temperature control.

Under the best circumstances there should be a gradual rise to a maximum figure of about 120°C., followed by a slight fall in temperature towards the end of the operation. The sheets should emerge, not 100% dry, but containing sufficient moisture to ensure that they remain flat subsequently. In a dry climate, such as that of the Sudan, this final moisture content is important, and while it is desirable from an economic point of view to sell the boards with as much moisture as possible, the moisture content of the board emerging from the dryer should not be much less than about 5%. Any drying out before use should take place naturally, with a minimum of warping.

A number of defects were observed with this machine. In the first place it was considerably overmanned, 4 men, with 2 servers, being used to feed it. The 1 man and server taking the board off the machine at the other end are satisfactory. Some of the thermometers were obviously inaccurate, and the accuracy of others is questionable although it was not possible to test them. As regards the gradation of temperatures, some typical figures obtained while drying thick board were as follows (see Table 2).

(i) 93 - 142 - 130 - nil - 157 - 138 - 150

(ii) 93 - 137 - 132 - nil - 155 - 130 - 143

(iii) 88 - 125 - 115 - 130 - 140 - 125 - 135

Under these conditions it is impossible to obtain controlled and uniform drying. Even if the thermometers record properly, there is no control of individual sectional temperatures, since there is only one main steam-inlet control. Nor is there humidity control, although according to the specification an instrument for this purpose was to have been supplied. The dampers installed for such control as is available, were poor in construction and crude in design and were not being used at the time of my visit.

A particularly serious defect was the fact that the top wire tended to run to one side, so that its edge overlapped the first row of boards resting on the bottom wire. Since both edges of both wires were badly damaged throughout their whole length, the above defect meant that the sheets were being badly marked (and thin boards were perforated) by the edge of the top wire running on them. A wire guide should have been installed to rectify this wandering trouble, and in any case the wires themselves should have been replaced once the edges became damaged. A supply of spares was in fact, on the premises at the time of my visit.

According to the specification this drying machine should be able to process 14 tons per day of board, having a moisture content of 55% on entering and 10% on leaving. In order to achieve this, Grades Nos. 90 to 30 are put through the machine once, but the heavier boards (Grade No. 18) require 2 passes. The first pass is obviously insufficient to dry the boards adequately, but the second pass tends to overdry them, and this accentuates the "bubbly" trouble referred to above.

When it is wished to produce a high final finish, it is desirable that the boards come out of the dryer with moisture content of 15%, or even more, as this is essential for effective calendering. If calendering does not then take place immediately or soon, the boards dry out and the effect of this moisture is lost. A dampening machine is in fact provided for treatment of the boards between these two operations, but it does not appear to be used. Actually it is an extremely crude piece of equipment, consisting of strings on rolls, which carry the boards a short distance under somewhat crude sprays.

At the time of my visit the maximum speed obtainable from the dryer was 8 metres per minute, but possibly with an altered motor-setting a higher speed could be obtained. The PIV gear was not working at the time, so that the maximum speed obtainable could not be ascertained. In any case this would have been a dangerous operation with the top wire askew as described above.

Tables 2 and 3 show the results of two tests carried out on the dryer during the period of my visit. Test I (Table 2) was made on No. 18 Grade board, which being a heavyweight, had to be passed through the dryer twice. It will be seen that the sheet weights (in kgm.) varied from 3.10 to 4.25 after pressing, and from 1.05 to 1.90, dry-basis (as against 1.24 specified in Table 7) after the second drying stage. The difference between the average sheet weights after the first and second dryings, namely 2.49 and 1.47 kgm., respectively, shows the necessity for the second drying stage. Nearly as much water is removed in the second drying stage as in the first.

Table 2

DRIER TEST - I

NO. 18 GRADE - 25TH NOV. 1967.

Sheet Weights (kg. per sheet).

	after pressing	after 1st drying	after 2nd drying	
	3.62	2.00	1.70	
	3.90	2.15	1.40	
	3.80	2.40	1.60	
	4.20	2.80	1.90	
	3.60	2.20	1.35	
	4.00	1.90	1.30	
	3.90	2.60	1.10	
	4.25	2.80	1.05	
	3.10	2.30	1.80	
	3.80	2.50	-	
	3.70	2.50	-	
	4.10	3.20	-	
Totals	45.97	29.35	13.20	
Average	3.830	2.490	1.467	
Water	61.8	41.1	-	per cent.

Passes through drier	-	2
Drying time per pass	-	17 min. 40 sec.
Drier length	-	25 metres.
Sheets per hour	-	1 70
Weight of cardboard dried	=	249 kg./hr.
	=	6t./24 hr. (approx.)

Time	Drier thermometer readings (°C.)						
12.10	93	142	130	nil	157	138	150
12.30	93	137	132	nil	155	138	143

Note. It is assumed that the board was 100% dry after the second drying.

Table 3

DRIER TEST - II

NO. 48 GRADE - 27TH NOV. 1967.

Sheet Weights (kg. per sheet).

	after pressing	after drying
	1.45	0.50
	1.55	0.50
	1.65	0.55
	1.65	0.55
	1.55	0.50
	1.55	0.50
	1.55	0.55
	1.55	0.55
	1.50	0.50
	1.55	0.60
	1.50	0.55
	1.55	0.55
Totals	18.60	6.40
Average	1.55	0.535
Water	65.5	- per cent

Passes through drier	-	1
Drying time	-	6 min. 15 sec.
Drier length	-	25 metres.
Sheets per hour	-	960
Weight of cardboard dried	=	513 kg./hr.
	=	12.3 t./24 hr. (approx.)

Note. It was assumed that the board was 100% dry after one passage through the drier.

[illegible]

[illegible] dings are given, and [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

2 [illegible] calenders and [illegible] by one man with another man at the exit end. [illegible] point of view this is an [illegible] process [illegible] the calenders seem to be capable of giving satisfactory results if properly operated. Proper operation depends on the sheets of board having the correct [illegible] and on temperature and pressure [illegible] the [illegible] calender. Neither of these requirements [illegible] on the occasion of my visit. [illegible] The [illegible] are crude in construction and although there is [illegible] adjustment the absence of a setting scale prevents [illegible] satisfactorily.

[illegible] the edges of the boards are trimmed. [illegible] there are two machines [illegible] in the two [illegible] edges [illegible] capacity [illegible] 300 kgm. per hour. In the first trimmer [illegible] are fed in singly by hand and are then gripped by [illegible] pulled through the [illegible] pairs of adjustable circular knives which [illegible] edges [illegible] required width. [illegible] in a manual [illegible] accurate feeding of the sheets [illegible] but [illegible] because the sheets are [illegible] higher [illegible] the top of the edge. In any case the [illegible] grippers is such that it pulls the sheet askew as it passes between the trimming knives. The result is that the board is [illegible] almost invariably out of square [illegible] which [illegible] scale [illegible]

[illegible]

[illegible] the second trimmer, which deals with the short edges in a similar way, there is also a leading edge and in addition a [illegible] bar which slides forward in open grooves in the feeding plate of the trimmer. Thus the operator places the sheet against the leading edge and [illegible] forward to the bar, which should be at right angles to the edge. In actual fact there is such [illegible] play of the bar in the grooves that right angled edges are produced only by accident. With quite a number of sheets [illegible] from the trimmed pile, there were at least 2 cm. [illegible] difference in the lengths of the diagonals from corner to corner. It should be noted that a very frequent customer complaint is that the boards are not squarely trimmed.

[illegible] trimming machines are very [illegible]. [illegible] the [illegible] boards are brought up to the trimmer in small [illegible] by a [illegible] and placed on the floor. The [illegible] operator [illegible] have to bend down for [illegible] to [illegible] obviously picks up many sheets [illegible] consequence the out of square [illegible] [illegible] method adopted should be that [illegible] trimmer [illegible] which a server places a supply [illegible] table [illegible] left side of the machine [illegible] that the [illegible] and feed them [illegible] trimmer has been [illegible] stanchion supporting the [illegible] possible to install a table in the [illegible]. However, it should not be difficult to overcome [illegible] by installing a table [illegible] right hand side of the trimmer, which is less convenient. Although a satisfactory serving table exists for the second trimmer, a man stands by it handing each sheet in turn to the trimmer operator although almost elbow to elbow with him.

The trimmed sheets are now sorted by an operator who picks out those having obvious defects which are [illegible] for repulping. A similar sorting operation is carried out at all the stages from the dryer onwards, so that the last operator is concerned only with defects which have escaped the earlier sorting. The sheets are then weighed, packaged and labelled. All these operations are carried [illegible] and there is considerable opportunity for [illegible] increasing production.

The stocks of finished board are normally stored in [illegible] at the time of my visit a fairly large quantity [illegible] doors. This is partly [illegible] and yearly stock-taking, but it was said [illegible] exposure to the sun was causing much wastage by [illegible]

[illegible]

[illegible]

The [illegible] factory operates according to [illegible] employment is concerned. Wage rates [illegible] only [illegible] a 6 day week, the duration of the [illegible] 8 hours, but a 1 hour meal-break is [illegible]. This is unusual in a factory which works [illegible] process, and means that there can be a [illegible] change of workers on the same job during one shift.

This break in continuity in itself is not good with a continuous process, and it also means in effect that some 12.5% more workers must be employed than is really necessary. Moreover some workers must be capable of doing more than one type of job. [illegible] paper mills a short meal-break is usually taken in the mill itself (15 mins. per shift), and where this is not possible the operatives eat at their posts. However, it is appreciated that it may not be possible to change the system at Arame, and the present procedure is taken into account in the recommendations made.

In the Government wage scheme, monthly rates for a particular wage group rise annually for 6 to 10 years (Table 4). They also vary according to the type of work done. At the Arame factory 6 wage groups are involved for employees (Table 5) and 3 wage salary scales for staff grade employees (Table [illegible]).

Table 5 is a classified payroll schedule of the factory [illegible] for 1966-67. Table 6 gives corresponding figures for administration and technicians for the same period. It will be noted that the number of employees involved total 103 and 8 respectively, total 111. It is not believed that any reduction [illegible] [illegible] in the administration and technician staff, but it [illegible] clear that considerable economies in labour could be made in the working of the mill itself. It is of course appreciated that in the case of a new industry starting up in a remote part of the country (as with the cardboard factory) one must expect to employ more labour for a given output than would be necessary in a developed industrial community. This assumption might be valid for the first year or two of a factory of this nature but it must be borne in mind that it has now been running [illegible]

Table 4

AROMA CARDBOARD FACTORY
INCLUSIVE LABOUR PAY RATES (£. PER MONTH)

Group	Initial	Final	Average
1	7.300	9.800	8.600
2	8.100	11.500	9.800
3	10.300	15.400	12.900
4	13.400	21.200	17.300
5	19.000	29.000	24.000
6	29.000	35.500	32.300
7	29.000	48.000	37.000

Note.

The figures in Columns 2 and 3 are the starting rates and the rates after annual increments over 6 to 10 years at the same type of work, respectively. Rates used in the present calculations are the averages given in Column 4.

Table 5

AROMA CARDBOARD FACTORY

PAYROLL OF FACTORY WORKERS

(1966-67)

Section	Total	Group 1		Group 2		Group 3		Group 4		Group 5		Group 6		Total per month (£.)	Total per year (£.)
		No.	Pay (£.)	No.	Pay (£.)	No.	Pay (£.)	No.	Pay (£.)	No.	Pay (£.)	No.	Pay (£.)		
Power Station	6			1	12.325	3	48.720	1	20.720			1	39.730	121.495	1,457.94
Electric Section	3			1	13.485			2	49.950					63.435	761.22
Boiler Room & Maintenance	13			2	29.145	9	148.045	5	20.720	1	30.140			228.050	2,736.60
Production	30			21	275.210	4	63.655	5	97.720					136.585	5,239.02
General Dept.	48	23	267.100	19	276.940	5	85.695	1	26.880					656.615	7,879.38
Supervision	3	2	22.910	—	—	1	14.935	—	—	—	—	—	—	37.845	454.1
	103	25	290.010	44	607.105	22	361.050	10	215.990	1	30.140	1	39.730	1,544.025	18,528.30

Note. Unless otherwise stated, salaries are per month and include Cost of Living Allowance and rent-free housing.

Table 6

AROMA CARDBOARD FACTORY

PAYROLL OF ADMINISTRATION AND TECHNICIANS

(1966-7)

Section		Scale J No.	Scale J Salaries	Scale J-H No.	Scale J-H Salaries	Scale H No.	Scale H Salaries	Total salaries per month	Total salaries per year
Administration	6	4	119,196			2	92.951	212,147	2,545.764
Technicians	2	—	—	2	94.910	—	—	94.910	1,138,920
	8	4	119.196	2	94.910	2	92,951	307.057	3,684,684

Note Unless otherwise stated, salaries are per month and include Cost of Living Allowance and rent-free housing.

years and that most of the operatives should by now have become familiar with their particular tasks. The labour question therefore becomes one for study and re-organisation, rather than of mere adequacy of numbers.

This question has a long-term and a short-term aspect [illegible] in the near future [illegible] immediately and under the latter are the labour schedules which will become operative under the scheme recommended in Part V for the revised operation of the mill.

During my visit I studied the various operations and especially those involving labour of an unskilled nature. As [illegible] recommendations [illegible] put forward [illegible] These are [illegible] recommendations in Para [illegible] and they were agreed [illegible] presently [illegible] that [illegible]

[illegible] might be [illegible] However [illegible] achieved [illegible]

[illegible] 4,000 tons [illegible] referred to [illegible] calculations given [illegible] long-term [illegible]

[illegible]

difficulties involved are appreciated, but much depends on the calibre of the foremen and senior technicians. It is particularly important that they realise (more than is perhaps the case at present) the importance of utilising man power to the maximum extent, of constant supervision to ensure that work is being done properly, and that surplus labour is being utilised efficiently. Supervision is a matter on which a report of this nature cannot make specific recommendations; it can only draw attention to the fact that the present state of affairs requires attention and improvement.

Water Supply and Effluent

Since the water supply for the factory is piped from Kassala, and there is no other supply, the amount consumed is measured for charging purposes. For the year ended 30th June, 1967, the total volume used was 66,047 cubic metres which, at a price of £ 0.03 per cubic metre, cost £ 1,981.410. This was used apparently to produce only 200 tons (gross) of paper, corresponding with a water consumption of about 330 cubic metres per ton of paper made. A reasonable average consumption figure would be 180 cubic metres per ton, but however, under good working conditions a figure of 100 cubic metres per ton should be obtainable; the specified figure was 65, which is extremely low for this class of product.

Whilst it might be regarded as unreasonable to expect a figure of less than 180 cubic metres per ton under the circumstances, there is obviously scope for considerable economy and this becomes very important in view of the relatively high cost of the water. Water may be saved [illegible] two ways, namely, by economy in use and by re-utilisation of waste water. The former is a matter of supervision, which has already been dealt with above. So far as the waste waters are concerned, these are of two kinds namely, liquor drained from the digesters and the washings which subsequently arise from the screw press thickener and screens; and the back-water from the 5 board making machines i.e., the water which passes through the wire of the rotating cylinder, as the mat of fibre is deposited on it. All of the above are at present run to waste, except for a small amount of backwater which is returned to the disintegrator of the pulp preparation plant (Fig. 2).

Much of the washings, liquor, backwater etc., are discharged together into large tanks outside the machine house. Here a certain amount of sedimentation of the fibre present takes place, and the liquor above it is allowed to flow to waste as effluent. The tanks used for this purpose are sectionalised so that as fibrous sediment builds up each can be isolated in turn, the fibre removed, and the clean tank brought into the system again. Unfortunately, the fibre obtained as a result of this cleaning process is not re-used, and much valuable material is obviously thereby lost. Quite simple savealls are available for recovering fibre from backwater, and suggestions for doing this are set out in the recommendations in Part IV.

The effluents coming from the tanks after sedimentation are piped some 2 km. away from the mill to an open space in the desert where they are allowed to evaporate in a shallow basin

Since it is apparently difficult to keep this area enclosed, it is usual to find herds of goats and other cattle drinking the effluent. This is not discouraged by their owners because apparently (and remarkably) it does not harm them and the effluent is free, whereas water has to be bought since it is piped from Kassala. If illness was to result, the cardboard factory would no doubt be blamed, possibly with serious consequences, especially if by mischance a human had occasion to drink this water or other water containing it. This unsatisfactory position should be rectified by a different method of effluent disposal which would reduce both its quantity and the losses involved, and on this also recommendations are made in Part IV.

Paster

A pasting machine is provided. Its purpose presumably, is to line the board with a white facing where necessary, and so produce the equivalent of a white lined boxboard. It is 700 mm. wide and therefore, takes a single sheet as coming off the board machine; specified capacity 16 tons per day.

White lined boxboard is in demand in the Sudan (see Part III, c), but the white lining paper would have to be imported. I understand that the paster has never been used.

Laboratory

The equipment supplied in accordance with specification was as follows

Pulp and paper drying oven	-	Satisfactory
Furnace for ash determination	-	Not used
Balance	-	Of the poorest quality and operating inaccurately at the time of my visit.
Tensile strength tester	-	Not the usual type for this class of material and not being used; in any case the tensile strength test is of no significance with this class of board.
Wetness tester (Schopper Riegler)	-	Satisfactory, but could not be used during my visit because it was not possible to check the consistency of the pulp being tested, and on this depends the type of cup used in the wetness test.
Micrometer for testing thickness	-	This is poor in quality and unreliable in design; it operates by a spring instead of a dead-weight and the area tested is far too small.
General	-	The laboratory has no water supply, and as it is also the First Aid room this is a serious shortcoming. I found that wetness, moisture and basic weight tests were being made and recorded although, as pointed out above they could not be accurate. However, no use was being made of the results, so that the tests were in any case a waste of time. This is unfortunate because the actual laboratory work was being done well.

Technical Control

No factory operation, however small and simple, can hope to function really efficiently without some measure of technical control. This has obviously been realised by the original proposers of the project since a laboratory was installed. As stated above it was provided with certain necessary testing methods, but there is no satisfactory means for testing the final board and there are no standard data against which to evaluate the factory operations

In the recommendations given in Part IV below therefore, a definite schedule of testing has been drawn up and it should be the responsibility of the factory manager to see any departures from specification found by testing, and to rectify the position without delay

Mechanical

The general maintenance was found to be poor, and some examples have been given above. In many instances there were signs of inadequate lubrication and of inadequately guarded machinery. The safety railings on the top floor of the digester house are frail and present an accident risk. In general there appears to be a general lack of spares, this is attributed in part at any rate, to the delay in obtaining supplies owing to the shutting of the Suez Canal

In addition to several minor mechanical breakdowns, there was a prolonged electrical shut down during my visit due to the compressor. This was eventually rectified with assistance from equipment borrowed from the Gash Agricultural Cooperation Board but it was necessary to send to Kassala (a 7 hour journey by night) for a filled air bottle. It was also necessary to borrow a Lister diesel set for emergency lighting so that the work could be carried out at night. The Aroma factory should be independent in this respect at least

Under present circumstances of course, with the mill running only one shift in any case, a shut down for mechanical trouble is not of such great importance except insofar as it brings men in to work unnecessarily and keeps them hanging about with nothing to do. However, a relatively new factory such as this, should require comparatively little major maintenance after 3 years, and the operation of a system of organised preventive maintenance should practically eliminate shut-downs under the present system of working.

(c) The Product and its Markets

Introduction

As already stated the mill was intended originally to produce 4,000 tons of board (mostly millboard, but some specialty board products) per annum. Presumably the paster was to be used to produce the latter. The estimated average selling price was £ 73 per ton ex factory. In actual fact the mill is at present producing 600 tons per annum (of which 300-400 tons is saleable); and it is having great difficulty in selling this at £.45 per ton delivered Khartoum, in spite of the fact that its production cost appears to be about £.513 per ton, excluding depreciation and interest charges (Part III. d)

It was therefore necessary to pin-point the reasons for this considerable discrepancy in demand and value and accordingly, visits were paid to selected customers, with the object of obtaining their views. Other market factors which might influence sales were also investigated and finally, some thought was given to the possibility of producing a higher-priced and more saleable product.

Table 7. lists the grades of board made by the factory. These are defined in terms of the Grade Number (in the second column) which is the number of sheets of board containing 10% moisture, weighing 25 kgm. The corresponding basis weights in grams per square metre are shown in column 3; and the corresponding thicknesses in column 4. It will be seen that

Table 7

AROMA CARDBOARD FACTORY
GRADES MADE

Number of sheets per 25 kg.				Weight of Sheet (gm.)			Dryness (%)	
Wet	90% dry (Grade No.)	Basis Wt. (gm./sq.m.)	Dry thickness (mm.)	Wet	90% dry	100% dry	From machine	From press
5	8	4,470	4.70	10,000	3,100	2,800	28	35
6	10	3,580	3.75	7,800	2,500	2,250	29	35
7	12	2,980	3.75	6,250	2,080	1,870	30	36
9	15	2,380	2.50	4,850	1,670	1,500	31	37
11	18	1,980	2.08	3,900	1,390	1,250	32	37
12	20	1,780	1.88	3,400	1,250	1,120	33	38
15	25	1,430	1.50	2,730	1,000	900	33	38
18	30	1,190	1.25	2,200	835	750	34	38
21	35	1,020	1.08	1,900	715	645	34	39
24	40	890	0.94	1,650	625	555	34	39
27	45	790	0.84	1,430	556	500	35	39
30	50	715	0.75	1,300	500	450	35	40
33	55	650	0.69	1,170	455	410	35	40
36	60	595	0.63	1,040	417	375	36	40
42	70	510	0.54	890	358	320	36	41
48	80	446	0.47	780	313	285	36	41
54	90	396	0.42	680	278	250	37	42
60	100	357	0.38	610	250	-	37	42

the sheets are graded so that the lightest (No. 100) contains 100 sheets of air dry board per 25 kgm weight. The heaviest (No. 8) comprises only 8 sheets per 25 kgm. Table 7 also shows the dry solids contents of the boards as they come from the machines and from the presses (columns 8 and 9 respectively). These are target or specified figures but there is no means of checking whether they are in fact being attained in practice. So far as visual observation is concerned the heavier weights appeared to have higher moisture contents than the figures shown in column 9 (after the presses).

Table 8 gives a list of the principal customers and their locations at the present time, and the numbers in the last column correspond with the grades supplied as set out in column 2 of Table 7. Table 9 gives the monthly sales of the various grades of paper made and it will be seen that for the year ended 30th June 1967, approximately 312 tons were sold. This corresponds with only approximately 1 ton per working day, although in practice more was apparently made though not sold (i.e. put into stock). The sales correspond with an average selling price of £ 45 per ton. Actually the price ex mill is £ 40 per ton but an additional £ 5 is added to cover the cost to Khartoum, which in fact is approximately £ 3 per ton. Table 9 also shows that the grade most in demand is No 30, of which approximately 98 tons were sold in the year, followed by No 20 (75 tons). No. 90 is the only other grade of any consequence, 43 tons having been sold in the year.

Table 8

AROMA CARDBOARD FACTORY

PRINCIPAL CUSTOMERS

1967

*Government Printing Press	Khartoum	15, 25, 30, 35
*African Sweet Co.	Khartoum N.	90
Abdalla Muhd. Bashir	Port Sudan	20
Kashm El Girba Sugar Factory	New Halfa	10
Gash Board	Aroma	10
*Stores & Equipment Dept.	Khartoum N.	15, 25, 30, 35
Trading School	Aroma	18
Bedami Abdel Aal	Kassala	18
*Hussein Derdir Rodwan	Omdurman	18
Mahd. Al Rahman Nugdalla	Omdurman	18
L.G. Michalidis	Khartoum	18, 40
*Survey Dept.	Khartoum	18, 20

* large users.

Table 9

AROMA CARDBOARD FACTORY

PAPER SOLD (1966/1967)

Month	Total £.	Amount tons	No. 10	No. 15	No. 15/A	No. 18	No. 20	No. 25	No. 30	No. 35	No. 40	No. 55	No. 90
July	12.000	0.3	0.3										
Aug.	737.500	16.5				1	6						9.5
Sep.	2,227.750	49.5				1	3	3	37.5		2		3
Oct.	2,011.500	44.5		5		2.5	18		12.5				6.5
Nov.	2,212.000	49.0			5	8.5	9.5		10	10			6
Dec.	1,307.000	29.0		10			13						6
Jan.	2.000	0.05				0.05							
Feb.	721.000	16.0					4						12
Mar.	1,203.000	27.0		1			3		13	10			
Apr.	16.000	0.4				0.40							
May	517.000	11.55					6	5					
June	3,120.250	69.35		15		1.10	12.5		24.9	13.6		2.28	
	14,087.000	312.60	0.3	31.0	5.0	14.55	75.0	8.0	97.9	33.6	2.0	2.28	43.0

Tables 8 and 9 and the general comments on drying calendering and trimming mentioned in Part IIIb, indicate defects in the finished product which might well be the reason for the low sales experienced. A visit was therefore made to some selected customers to obtain first-hand views, and the results of these are set out below.

Customer Enquiries

The Packaging House Ltd

This Company manufactures cartons, boxes, cement sacks, etc., and has a modern corrugating plant which however, does not run at full production; present production is 50 tons per day. They have tried to use the Aroma board, but without success because they cannot print it and it cannot be folded for box making. Since their product is mostly lined and printed, they have no real outlet for the Aroma board, but they would welcome from Aroma a suitable corrugating medium i.e., for making the fluting or corrugated papers inside corrugated cartons (see Part IV b). Their outlook is probably coloured by the fact that they intend to erect a paper machine to process their own waste material, of which they have 1 - 5 tons per day, together with imported pulp. In this way they hope to make the corrugating medium which at present they import from Scandinavia.

Blue Nile Packaging Co., Ltd.

This Company operates similarly to The Packaging House Ltd. They are not at present using Aroma products, but have examined some of the board produced and have pronounced it as unsuitable because it is brittle and cracks when folded. They have a paper machine to convert their own waste. This is pulped in a drum with water, cleared in a hollander and made into paper continuously on a cylinder mould machine. It is reeled wet and cut off at the required thickness in a manner similar to that used at Aroma; the sheets are pressed hydraulically, and hung to dry in sheds. They are then calendered in the cold state, to remove waviness, and sold as sheets, the output being 2 tons per day. Blue Nile do not use any themselves; it is all sold, presumably to the same customers who buy or would otherwise buy the Aroma board. Their product compares very favourably in appearance with that from Aroma. The selling price not known.

Blue Nile also, are likely to be in the market for corrugating medium, usually 127 grams per square metre on 140-cm. reels, 1.0 to 1.25 metres in diameter; they use some 1,000 tons of this per annum. A sample of the fluting at present imported from the United States and costing £.67 per ton c.i.f. Khartoum, was obtained, and is evaluated in comparison with the Aroma trial product in Part IV b. They also import white lined boxboard from Japan, but have had bad trouble with waviness.

Abdou Diab, Khartoum

These are suitcase manufacturers. They use the heavy Aroma board in sheet form, and find it satisfactory. The method of use is to sew the edges of the board together at the corners at right angles by hand-stitching, so that bending of the board is not involved. Indeed, they have no creasing machines. This method is very effective from the point of view of strength, but it is costly because it involves handwork and takes time. The board is then covered with a decorative plastic material. Suitcases imported (principally from the United Kingdom) are however, cheaper and better in appearance because they have rounded edges and, being made of vulcanised fibre, are very strong.

Tahamine Sac, Khartoum.

These use Aroma boards for stiffening ladies' handbags, between the plastic outer cover and the inside cloth lining. Complaints were received of uneven thickness, bad bending properties, and of large lumps in the board. They have however, been able to make use of the Aroma board by cutting out the defective portions, but this has involved waste and requests for a price allowance.

E. S. Mina, Box 1481, Khartoum.

They are interested in developing an industry for the manufacture of book matches, and it was felt that Aroma board might be satisfactory for this purpose. This should be followed up in any future plans for the Aroma factory.

Hussein Derdiri, Omdurman.

This is a middleman who buys approximately 120 tons per annum of Aroma board. He complains that his customers dislike the poor colour, the delay in deliveries, the badly dried edges and the lack of flexibility. He stated that an Italian board is preferable at £.43 per ton, and he mentioned an Egyptian board at £.30 per ton for which however, no import licences are obtainable. He himself has not passed on any complaints to the Aroma factory; he anticipates an increased demand in the future

Kamal Mohamed, Khartoum.

These are makers of handbags, who have tried the Aroma board but cannot use it.

Taha Hassan, Khartoum.

This also is a suitcase maker who complains of lack of uniformity in thickness, bad bending qualities, and a tendency to delaminate and to crack. He has found it possible to bend the thinner weights satisfactorily, but would like the board to be denser, i.e., more highly compressed.

Printing House Ltd.

This Company is associated with The Packaging House Ltd. The Sales Manager stated that Aroma board is used by them for bookbinding covers, of dimensions up to 50 x 35 cm. Criticisms were that it blunts the cutting shears and that the sheets are inaccurately cut, so that when the large sheets are cut down to the small sizes, there is wastage. This is due to the edges not being straight. He preferred the Blue Nile Packaging Co. Ltd., products (see above), although the Aroma board is satisfactory as regards rigidity.

Arabian Trading Co.

These are also merchants; their customers find that the Aroma board is strong enough, but that it breaks on bending and is difficult to cut.

Arabian Sweet Producing Co., Khartoum.

They take about 12 tons per month of the thinner Aroma boards, but in general, have little direct contact with their customers on technical matters.

Summary

The results of the above visits may be summed up by the statement that the Aroma board is not favoured because of its hardness, and the difficulty in bending it (which are largely due to the nature of the cotton stalk pulp); and also because it is not uniform in thickness and substance the cutting is bad, and the colour and surface are unsuitable for printing and poor in appearance. Where however, rigidity and hardness are all-important the Aroma board finds favour. These conclusions are fairly well in accord with the manufacturing problems being experienced in practice, and set out above in Part III b.

Existing and Future Overall Markets for Aroma Board.

Consideration was given to the problem of whether the market for the Aroma boards could be developed if a suitable product is produced. Table 10 shows the quantities and values of selected paper and board imports into the Sudan for 1966. To these should be added the board made by the Aroma factory and the approximately 2 tons per day made by The Blue Nile Packaging Co. Ltd. (i.e., approximately 600 tons per annum at the present time).

Unfortunately these statistics do not show how much board of the Aroma factory type is included in each category. So far as one can tell, the categories headed Kraft Paper, Building Boards, Coated and Paper Bags are all eliminated, because they include qualities which are quite different from, more highly priced than, and obviously much more in demand than the Aroma boards; for example, paper bags and cardboard

Table 10

SELECTED PAPER AND BOARD IMPORTS

(1966)

Type	Quantity kg.	Value £.	Value £. per 1,000 kg.
Kraft paper, Kraft cardboard	519,942	119,634	235
Other paper, paper board not further treated	421,528	57,287	136
Building boards etc., of wood pulp or veg. fibres.	5,159,278	218,193	42
Coated, surface coloured, decorated, grease proofed, etc., paper, paperboard in rolls sheets not cut to size.	1,195,432	72,721	61
Paper bags, cardboard boxes, etc.	2,305,839	371,076	-
Totals (all grades)	13,124,194	1,414,120	-

boxes which would be imported in their finished state. Kraft cardboard (if the term describes the product correctly) would be in the same category, but is a product of much higher quality than the Aroma board, and in any case most of the imports in this category are no doubt kraft paper. The only category left therefore is Other Paper, Paper Board not Further Treated, and of this some 422 tons per annum were imported in 1966. Since the average price is £.136 per ton, it would seem that most of this is paper rather than board.

The above deductions, for what they are worth, thus suggest that comparatively little board of the Aroma type is being imported into the Sudan; and when one excludes from the comparison the board supplied as reels as distinct from sheets, the possible amount is reduced even further. No doubt in the course of years the demand for a product of this nature will increase, but as matters stand at the moment, and perhaps for some time, it would appear that the market for the Aroma type of board is extremely small. This conclusion probably applied with even greater force in 1959 when the factory was first planned.

The other possibility, namely of obtaining a higher price for the Aroma board, was therefore explored. It is recognised that the low average price of £.40 per ton ex factory has been accepted by the mill because of the defects in and low quality of the board. However, information obtained from the Blue Nile Packaging Co. Ltd., and from Hussein Derdiri (see above) suggests that a product as good as or better than the Aroma board is obtainable from abroad at the same price or less. Unless therefore the Aroma board is very heavily protected there seems no possibility that a much higher price could be obtained even if the quality is improved materially. Under the most optimistic conditions an extra £ 5 or £ 7 per ton might be paid but this would make an insignificant difference to the loss position while present production conditions prevail.

One is therefore forced to consider the possibility of making other grades of product at Aroma (in addition to or instead of the board) which will sell for higher prices and for which there is a bigger market.

Possible New Products from the Aroma factory and their Markets

The limitation to developments of this nature are at the moment two fold namely the nature of the raw material and most important of all the fact that the Aroma factory can produce only sheets of paper or board and not reels.

The raw material position is still undecided (see Part III) and it is hoped that castor stalks, if suitably processed, will give better results than cotton stalks. It is also quite clear that the present method of processing does not get the best out of the latter. Assuming that these hopes as to raw material are realised (and there is a reasonable possibility of this being the case), then consideration must be given to the production of reels instead of sheets. This is because the market for boards in sheet form is extremely limited. Even if medium weight brown papers are made in sheet form, and experience has shown this should be possible (see Part V), there would still be only a limited market because they could be used only [illegible] wrappings and the fixed size of 70 x 100 [illegible] would be a great handicap.

[illegible] the other hand if reels can be made [illegible] much wider range of possibilities opens up. The low grade wrapping [illegible] will be supplied but a wider [illegible]

[illegible]

[illegible]

[illegible] machine [illegible]

[illegible] Packaging House [illegible]

[illegible] together [illegible] approximately 2,000 [illegible] per annum

[illegible] a rapidly growing market [illegible]

[illegible] articles [illegible] products [illegible]

[illegible] made below [illegible]

[illegible] A further possibility [illegible]

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[illegible] basis [illegible]

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[illegible] been [illegible]

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[illegible] card [illegible]

[illegible] Khartoum [illegible]

[illegible] 300 tons per annum.

[illegible] set up [illegible] making [illegible]

[illegible] the industry [illegible]

[illegible] The Aroma [illegible] would make [illegible]

[illegible] fluting [illegible]

[illegible]

[illegible]

[illegible] be required [illegible] [illegible] paper could possibly be used [illegible] to take lighter [illegible]

[illegible] appreciated that many of the products referred [illegible] require [illegible] lower basis weights than are normal [illegible] Factors [illegible] Part [illegible] [illegible] were [illegible] and [illegible] they [illegible] purpose [illegible] but they are [illegible] potential of the market and of the average [illegible] [illegible]

[illegible]

[illegible] when [illegible] paper [illegible] approximately [illegible] per [illegible]

[illegible] Papers [illegible] have [illegible] paper [illegible] produce [illegible] [illegible] ly [illegible] it was [illegible] breaks [illegible] the ordinary [illegible] and [illegible] than 5% [illegible] would [illegible] value [illegible] than [illegible]

[illegible] appear [illegible] Acme pulp [illegible] be very [illegible] since the [illegible] approximately $ [illegible] 8 per ton and the yield [illegible] than 50%

[illegible] Packaging Co. Ltd

[illegible] Khartoum [illegible]

[illegible] medium	$ [illegible]7 per ton
[illegible] kraft	$ [illegible]5 per ton
[illegible] board [illegible]	$ [illegible]92 per ton

[illegible] Ltd

[illegible] was given [illegible] deduction [illegible] price [illegible] approximately $ [illegible]5 per ton [illegible]

[illegible] Ltd

[illegible]	$ [illegible]5 per ton

[illegible] Company

[illegible] Khartoum [illegible]

[illegible] high grade [illegible]	$ [illegible]9 per ton
[illegible]	$ [illegible]50 per ton
[illegible]	$ [illegible]5 per ton
[illegible]	$ [illegible]50 per ton
[illegible]	$ [illegible]50 per ton
[illegible]	$ [illegible]40 per ton

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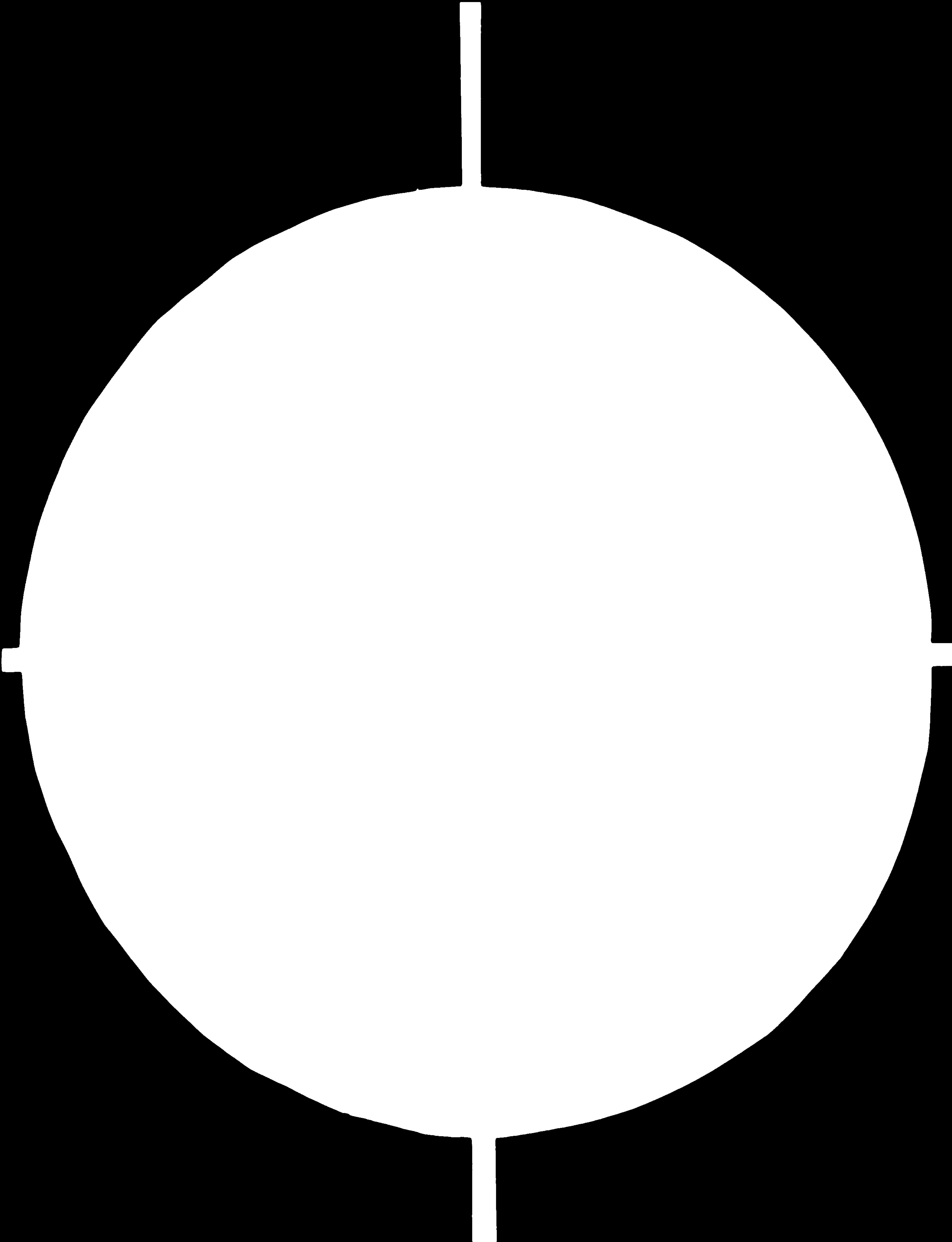

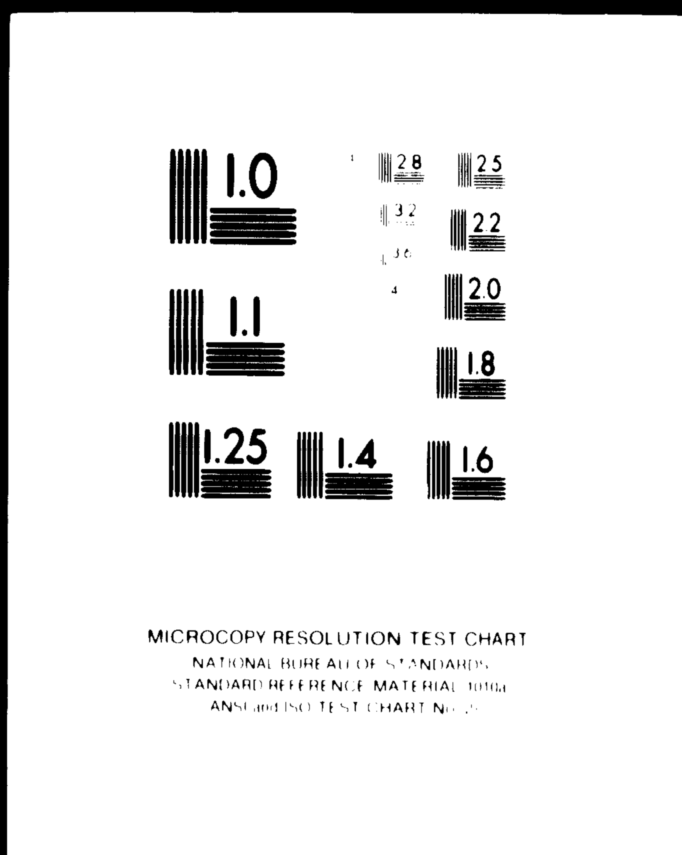
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are not used, but if they could be produced in such quality as to substitute the above for use in partitions and ceilings (thickness, 1 cm., minimum) and having a paintable surface, then a use could probably be found for them. It is important also that these materials can be nailed and that they are fire-resistant. In general, the British Standard Specifications apply to products of this nature. The National Building Research Institute was visited in the same connection, because it was believed that they had investigated the possibilities of this type of material for constructional work. However, no such work has been done. It seems therefore that the use of Aroma board for constructional purposes involves technical considerations at present outside the scope of the mill, and this possibility seems hardly worth exploring further at this stage.

Conclusions.

Information obtained during this survey suggests that if the Aroma factory could produce material of suitable quality, then the following average selling prices would approximately apply (per ton c.i.f. Khartoum).

Imitation kraft	£.66
Fluting	£.66
Thin boards and folder "Manilla"	£.93
White-lined box boards	£.88
Boards	£.57-65

The statistics given in Table 10 for 1966, and the enquiries made above among prospective customers, indicate that there should be ample outlets for the consumption of these products by the Sudanese markets at present, and certainly in the future, even if the mill was capable of running at its full estimated production of 4,000 tons per annum.

The implementation of the above possibility has therefore next to be considered and this is done in Part IV under the heading of long-term recommendations.

(4) Production Cost

It is difficult to deduce reliable figures for the production cost of the board at the present time. The office records have been well kept, but the accuracy of the data on which they are based is questionable because there are no proper methods of measuring the materials used and the board made. The greatest likely source of error is the proportion of substandard board; while the amount of board sold is known accurately, the amount made is not. The cotton stalks, used cement sacks and caustic soda have all been in stock for some time, and any production cost calculation can only be based on out-of-date values. The moisture content of the board sold varies, probably between 2 and 8%, and this introduces another source of error.

An attempt has been made however, to calculate production cost for -

(a) Year ending 30th June, 1967.

(b) Assuming that the factory is in a position to make 4,000 tons gross, per annum of board of reasonable good quality with a reasonable degree of efficiency, i.e., as originally planned.

These are shown in Tables 11 and 12, respectively, with explanatory notes.

Table 11 is based mainly on data taken from the factory records. These show that in the year in question, 350 tons of cotton stalks and 45 tons of waste paper were used. Assuming yields of 50% and 75%, respectively, these are equivalent to approximately 200 tons of paper (gross) per annum. Actually, according to the records (Table 11), 312.6 tons were sold in the year. The difference presumably, must have come from existing stocks. References to production cost data and losses are made in the correspondence files of the factory (see Part II), but it is not clear how these figures were calculated.

The present mill figures therefore, do not enable the amount of substandard paper made to be calculated; this should be given by the difference between the yield tonnage and the tonnage sold. For the purpose of the present calculation a figure of 10% has been taken but there is reason to believe that this is far lower than reality.

The calculation must therefore be taken as of very limited accuracy but it is conservative, and the loss shown is probably less than the true loss. This amounts to £.84,780 for the year; or if interest charges are not taken into account, £.60,780. Apart from interest and depreciation charges the figures which contribute most to the loss are the high labour costs and the low selling price quite apart, of course, from the low overall production.

Table 11

COST SHEET

(YEAR ENDED 30TH JUNE, 1967.)

	Item	Quantity	Unit Price	Cost p.a. (£.)
1.	Cotton stalks	T.350	£. 2.9	1,015
2.	Waste papers	T. 45.1	£. 8.0	361
3.	Caustic soda	T. 30	£.37.0	1,110
4.	Chemicals	0.6	£.22.0	13
5.	Water	66,047 cu.m.	£. 0.03	1,981
6.	Diesel oil	T.159	£.19.47	3,096
7.	Fuel oil	T.200	£.11.01	2,422
8.	Labour	103 men	-	18,528
9.	Management etc.	8 men		3,684
10.	Maintenance Materials	-	-	4,276
11.	Standing charges	-	-	6,555
12.	Depreciation	£.480,000	7.5%	36,000
13.	Interest	£.480,000	5.0%	24,000
14.	Total			103,041
15.	Substandard paper	T. 20	£.30.0	600
16.	Cost per annum			102,441
17.	Cost per ton saleable paper (dry basis)			£.570
18.	Cost per ton saleable paper (air-dry)			£.513
19.	Loss per ton sold			£.471
20.	Loss per annum			£.84,780

Notes

1 to 11, inclusive. From factory records.

10 - is made up as follows:

Felts	£.950.000
Wires	£.658.733
Spare parts	£.2,666.809
Total	£.4,275.542

11 - is made up as follows:

Local tax	£. 1,555
Insurance	£. 5,000
	£. 6,555

13. Excludes interest charges on working capital.

14. Total cost to produce T.200 of cardboard (gross, dry basis).

15. Assumes 10% of production (T.20) is substandard cardboard which has to be repulped for reuse. Value (say) 75% of the selling price, i.e., £.30.0 per ton (see 19).

17. Cost (16) divided by tonnage of saleable paper (T.180).

18. Correction for moisture, assuming the cardboard, as sold, contains 10% moisture.

19. Assumes a selling price of £.42 per ton, free on rail at factory.

On the other hand, as a production cost calculation Table 12 may be regarded as fairly accurate. It is the sort of result which might have been obtained had the factory met the specifications in terms of the quantity and quality of the board made. As compared with present conditions however, it is optimistic in almost every respect.

It shows that even under the favourable conditions assumed by the specification, the factory would be losing £.39,600 per annum, or £.15,000 per annum if interest charges are excluded. It would be necessary to sell the board at £.59 per ton in order to break even, a most unlikely possibility in the circumstances.

Obviously if the factory is to run at a profit, an entirely new production and sales policy is essential.

Table 12

COST SHEET

(TONS 4,000 GROSS P.A.)

	Item	Quantity	Unit Price	Cost p.a. (£.)
1.	Cotton stalks	T. 5,333	£. 2.9	15,470
2.	Waste papers	T. 1,067	£. 8.0	8,540
3.	Caustic soda	T. 533	£. 30.0	15,990
4.	Chemicals	T. 12	£. 22.0	260
5.	Water	720,000 cu. m.	£. 0.03	21,600
6.	Diesel oil	T. 2,000	£. 19.47	38,940
7.	Fuel oil	T. 3,000	£. 11.01	33,030
8.	Labour	200 men	-	36,000
9.	Management etc.	12 men	-	6,000
10.	Maintenance Materials	-	-	8,000
11.	Standing charges	-	-	6,600
12.	Depreciation	£. 480,000	7.5%	36,000
13.	Interest	£. 480,000	5.0%	24,000
14.	Total	-	-	250,430
15.	Substandard paper	T. 400	£. 36	14,400
16.	Cost per annum			236,030
17.	Cost per ton saleable paper (dry basis)			£. 65.6
18.	Cost per ton saleable paper (air-dry)			£. 59.0
19.	Loss per ton sold			£. 11.0
20.	Loss per annum			£. 39,600

Notes

1. Assumes 80% cotton stalks and 60% yield (dry basis); and that the stalks are moisture-free when purchased.

2. Assumes 20% waste papers and 75% yield (dry basis); at purchase price.

3. Based on price at Dec. 1967.

4. Based on present consumption.

5. Assumes 180 cu. m. per ton made.

6. Based on present consumption.

7. Based on present consumption.

8. Based on 1-shift scheme as agreed Nov. 1967.

9. Assumes small additional clerical staff.

10. Based on present requirements, viz. wires, felts and spare parts.

12. Based on present costs of local taxes and insurance.

13. Excludes interest charges on working capital.

14. Total cost to product T.4,000 of cardboard (gross, dry basis).

15. Assumes 10% of production (T.400) is substandard cardboard, which has to be repulped for re-use. Value (say) 75% of selling price, i.e., £.36 per ton (see 20).

17. Value as (16) divided by tonnage of saleable paper (T.3,600).

18. Correction for moisture content assuming the cardboard, as sold, contains 10% moisture.

20. Assumes a better grade of board, able to command a selling price of £.48 per ton, free on rail at factory; carriage to Khartoum is £.3.000 per ton. Present selling price is £.45 per ton delivered Khartoum.

PART IV

RECOMMENDATIONS

It will be apparent from what has been written in Parts I, II, and III, that any recommendations for the better running of this factory fall under two distinct headings, namely those which can be put into effect immediately or in the near future; and those of a long-term nature, which involve fundamental changes in manufacturing process and product. This Part therefore, will deal with them under their respective headings.

Short-Term Recommendations

Under this heading are listed the type of recommendations which can be put into effect immediately or almost immediately, and at relatively little cost. On the whole they comprise a large number of small items, but it is necessary to enumerate them. Many of them have already been brought to the attention of the mill management. As already explained, the introduction of these improvements where possible, is not likely to make any material difference to the present unsatisfactory overall financial position at the mill. It should however, serve to reduce the loss to some extent. The real answer to the present problem is far more fundamental, being dependent on the raw material used and on the type of product eventually made from it (see Long-term Recommendations, below).

The recommendations are tabulated under the sub-headings of the individual departments, operations or activities of the factory.

1. Raw Materials

(a) Experimental. Suggestions for dealing with the raw materials situation in view of the cotton stalks position are discussed fully in Part III. In this connection however, consideration was given to certain small-scale papermaking equipment at the Barakat headquarters of the Sudan Gezira Board, as it was felt that it might be of use in the experimental work involved.

The equipment was therefore inspected. It consists essentially of a 250-lb. 2-litre pipe-type digester, a small hollander beater, and a miniature vat machine with large dryer, slitter and reel; all apparently unused. The drawings and certain parts were missing and these are being sought. This is all well-made equipment, but not entirely suitable for the immediate experimental work on the Aroma problem; and its transfer to and erection in Khartoum, as proposed, would take time which cannot be spared in this connection. The plant, suitably supplemented, would be extremely useful if it is decided to make a fuller study of the papermaking raw materials and their possibilities for the Sudan as a whole.

(b) Purchases. Whether cotton stalks, castor stalks or other local raw materials are used, they should be purchased in the same way as sugar cane, i.e., on a direct cost basis, that is to say, cost of direct labour for collection and bringing to the baling point. It should be remembered that cotton stalks are a waste product; thus the farmer has already had his profit from the cotton, and that the stalks would otherwise have to be burned. The cost therefore, should not be more than that of the services of whoever does the collecting and transporting.

With cotton it might be difficult to alter the present established position, but if castor stalks are used then a fresh start should be made along these lines.

(c) Baling. Whatever raw material is used, it should be baled at the collecting point. A heavy-duty straw baler usually suffices for this purpose, although cotton stalks, if used, might prove more difficult than straw, owing to their stiffness. However, balers for this purpose are made, and are not expensive. Probably one baler could cover a whole district, and deal with all the material in it. Bales should be approximately 50 kgm., in weight and should be secured with strings, which are much less expensive than wires although wires can often be reused; however, care should be taken that strings are properly removed before the stalks go into the pulping process. Care should also be taken that the material is dry before it is baled.

At present the stalks are bought in terms of area (per feddan), and has been convenient while there are no means of weighing the stalks. It is however, preferable to buy by weight since the farmers may not clear the field completely when the area system is used. If the stalks are baled, then the bales can be weighed and the price based on the bone-dry material as determined by moisture tests made at the factory. The cost of the stalks will then be known accurately.

The advantages of baling are as follows:-

(1) A more rational method of purchase based on weight see above

(ii) Less costly transport from the fields to the mill. At present a 5-ton lorry takes only 1-ton of loose cotton stalks, whereas over 4 tons of baled cotton stalks could be carried for the same price.

(iii) Improved storage at the mill. The present untidy system with its fire-risk, would be largely eliminated, and the stalks would be stored in orderly stacks.

(iv) Insect attack would be reduced. The outside of the bales could be sprayed with an insecticide, and the inside would be self-protecting, to some extent at any rate.

(v) Handling of the bales in the store yard and into the cutter house would be greatly facilitated. At present there are considerable fruitless journeys to carry large bulks of cotton stalks which weigh comparatively little. With baled stalks a 24-hour supply could be bought to the feed of the cutter in a day shift and with a minimum of labour. If the bales have one dimension enabling them to be accommodated by the shute approach to the cutters, then feeding the cutters by one man with a hook would be a simple matter.

(vi) The bales can be weighed at the cutter feed, and it will then be known just what weight of material is being sent to the digester.

(d) Storage Yard. This is referred to under baling, above. However, steps should also be taken to reduce the considerable fire risk which exists at present, owing to the storage of considerable bulks of dry material and to the position of the mill in relation to the storage yard and the prevailing wind. Many sand and water pails are provided but, during my visit, they were mostly empty or almost empty. The fire risk will of course, be less with baling but this question of replenishing the fire buckets should be watched very carefully, not only here but all over the mill. There is a trailer pump available for fire fighing, but it would be of little use under present conditions. A pressure water point, with hose, should be located in at least two appropriate positions in the storage yard.

(e) Cutter House. The importance of measuring the stalks taken into the mill by weighing has already been emphasised Other points arising in the cutter house are

(a) The sieve on the screen is allowed to become blocked, and is frequently ineffective. This should be cleaned regularly after each shift, as a matter of routine.

(b) The outlot from the hammer-mill has no provision for returning unprocessed chips or pieces of stalk to the system. This should be rectified, either by addition of an auxiliary screen; or, if possible, by a stationary screen after the outlet from the hammer-mill. The rejects from this screen would pass on a moving band back to the feed of the hammer mill.

2 Digestion

(a) The level indicators of the caustic soda and water tanks should be repaired and properly used.

(b) The strength of the caustic soda should be titrated, and the figure used to calculate the actual amount to be added to the digester. It was shown in the mill trial that a caustic soda concentration of 8% is adequate under present digesting conditions, and probably further experiments would indicate that an even smaller quantity can be used.

(c) The thermometers on both digesters should be repaired and used. They will however, be less unless the air in the digester is vented after pressure has been raised and before cooking starts. This operation is very important. The conditions of digestion given in Part III b, should then be satisfactory to ensure good cooks.

(d) Unfortunately it is not possible to remove a sample of the pulp for examination and testing before emptying the digesters, as they are emptied under steam pressure. If a cook goes wrong therefore, it is not possible to re-cook the charge and it has to be sent to waste. As the present system is arranged there seems to be no way out of this difficulty, but the manufacturers of the digesters might be approached on the subject, since this is something that they should have foreseen.

(e) The liquor draining from the digesters should be collected in a tank and titrated. When the amount of residual caustic soda has been obtained in this way, the liquor should be returned to the caustic soda feed tank and made up to the requisite strength in respect of caustic soda, using fresh caustic soda. This liquor should be used for the next cook. It is appreciated that it may not be possible to use the whole of the caustic soda black liquor drained from the digesters in this way, because the dissolved organic solids will build up and impair the digestion. Experiments need to be carried out to ascertain the best balance between used black liquor and fresh caustic soda; possibly at least 50% of the black liquor could be used in this way, thereby not only effecting a considerable economy, but also an improvement in the mill effluent. This is dealt with further below.

(f) The rails on the top floor of the digester house, (the filling floor) are too fragile to be really safe and should be strengthened.

(g) The pits into which the digesters discharge are badly designed. The pulp lodges in them, and high-pressure water jets have to be used, with manual digging later, in order to transfer the pulp to the screw conveyors. Consideration should be given to relining the sides of the pits so as to eliminate the ledges which are the main cause of this trouble. It is understood that trouble was previously experienced with these pits.

3. Stock Preparation

(a) The moisture content and possibly the Na_2O content of the pulp should be ascertained before it enters the screw press.

(b) The wetness should be determined by the Schopper Riegler method after the pulp leaves the disc refiner. Further wetness tests should be made after the Nos. 1 and 2 refiners.

(c) Consistency tests on the pulp should be made occasionally before and after each refining and screening stage.

(d) If used (waste) papers are being added to the furnish at this stage, the amounts used should be weighed and care taken that a consistent proportion is used in relationship to the raw material from the digesters going through the mill.

(e) A consistency regulator should be installed before the pulp is diluted in readiness for the paper machine.

(f) The present sand-traps are of little use, but there is no harm, and perhaps some good, in keeping them in commission. However, they should be properly used, i.e., the baffles should always be in position; they should be cleaned at frequent intervals; and where the wood has warped so as to allow leakage under the baffles, this should be rectified.

4. **The Board Machines**

(a) Provision should be made for more accurate adjustment of the couching roll on the cylinder. The Specification refers to a felt-forming vacuum system, and pneumatic press control. These are important, but neither appears to have been installed.

(b) Felt conditioners should be installed.

(c) An improved thickness indicating device, preferably based on a warning light instead of, or as well as, a bell, should be installed.

(d) There should be regular tests of the consistency of the pulp entering the vat.

(e) There should also be regular tests of the moisture [illegible] the sheets being taken off the final roll.

(f) When making specially heavy substances, the double vat [illegible] No. [illegible] should be used.

(g) So far as possible, boards of the same or almost the same weights should be made at the same time on all machines. A [illegible] [illegible] final Schopper Riegler values corresponding with each basis weight should be drawn up. This could not be [illegible] time [illegible] for reasons already explained.

(h) Alum should be added to the machine chest to bring the pH value to about [illegible]. This can be done experimentally [illegible] system but at a later [illegible] [illegible] suitable [illegible] drip feed. The desirable [illegible] content can be judged from the absence of froth in the vats.

(i) The presses should be operated according to a fixed schedule as to time to raise pressure, time on pressure, pressure used, and release of pressure; and the moisture content should be determined before and after pressing. In this way the moisture content of the boards before entering the dryer would be standardised and some of the lack of uniformity in properties eliminated.

5. Drying

(a) All the thermometers on the dryer require attention, and their readings should be recorded and used to ensure efficient drying. The best temperature sequence is found by trial and error, but the following should give an indication.

80 - 100 - 120 - 130 - 130 - 100 - 80°C.

(b) Attention should be given at once to the badly-damaged wires, and wire guides installed to prevent the top wire "wandering" across the bottom wire as at present. Until the guides are fitted, care should be taken that the wandering is rectified manually.

(c) The method of temperature and air control on the dryer leaves much to be desired. At present it cannot be controlled with sufficient accuracy to ensure even drying. The views of the makers should be ascertained on how this can be improved.

(d) The PIV gear of the drive is not working, and should be rectified.

(e) Moisture tests on the paper should be made at regular intervals at the outlet end of the dryer.

(f) So far as possible the boards should reach the end of the dryer containing about 20% moisture. They will then be in better condition for the calendering operation, which should be carried out without delay before the boards have time to dry out.

6. **Calenders**

Moisture control should be carried out before and after the calenders and care should be taken to ensure that the second calender roll is adequately heated, as this was not so during my visit.

7. **Trimming Machines, Sorting and Packing.**

(a) The first of these machines, dealing with the long edges, should be provided with a serving table, and the pile of sheets on the machine at any one time should not be higher than the guiding edge used in feeding the machine.

(b) The grippers which pull the sheet through the machine should be adjusted, as at present they pull the sheet out of square just before the edges are cut.

(c) The second trimmer, dealing with the short edges, already has a serving table, but the device for squaring up the sheets before feeding them into the machine runs loosely in its grooves and gives inaccurate cuts. A longer and better fitting squaring device should be provided.

(d) The present crude methods of sorting and packing should be systematised and streamlined, and some of the unnecessary labour eliminated.

8. **Sub-standard Paper**

This, together with the trimmings, should be collected, preferably baled if for storage, and weighed each day, or more frequently as necessary, before being sent back to the repulpers. Board rejected because it is very dirty should not be repulped, but burned. If more than 10% of the total paper coming from the dryer (dry basis) is substandard, then an enquiry into the reason should be made.

9 Waste Waters

(a) Black Liquor from Digesters. So far as possible the black liquor should be reused (see above). Any black liquor that cannot be used however, should be ponded - preferably in the mill area. In view of its relatively small volume compared with the present effluent, the space required will be small and, with the high rate of evaporation usual in the Sudan, it should dry up quite rapidly.

(b) Backwater. Most of the remaining effluent comes from the washings and screens of the stock preparation plant, and from the backwater from the board machines. This is high in fibrous matter of value for the manufacture of the boards, and the fibre losses are probably considerable, although they could not be measured. At present all these effluents are combined with the black liquor and run into tanks outside the vat house. If these tanks are still used, without however including the black liquor, then their contents will consist of somewhat impure water plus fibre. A saveall should be installed to recover the fibre which can be collected and returned to the inlet of the pulp preparation stage (screw-press); for this there should be at least a simple conical saveall, which will pay for itself very rapidly. However, the more sophisticated types of saveall, and especially those which depend on flotation of the fibre and skimming off the floating portion, are much more effective and much more economical in the long run, and they can operate automatically. It is believed considerable sums can be saved here.

(c) Water. After removal of the fibre, the remaining water should be reused in the mill. Some is reused at present but, with the elimination of the black liquor, much more could be utilised; for example for filling digesters, for dilution at the stock preparation stage, and before the paper machine. If this system is tightened up the savings in water could be considerable and a heavy cost item reduced.

10. Labour

The mill is considerably overmanned in most departments, and at the time of my visit a suggested scheme for reducing the total payroll numbers from 111 to 83 (mill labour 103 to 74) was put forward. This is regarded as a first step, but even under present running conditions further reductions could be made. Tables 13, 14 and 15 embody the suggestions made.

11. Laboratory

The importance of adequate facilities for testing and control has been emphasised frequently elsewhere in this Report. It has also been stated that the laboratory as at present equipped and organised is inadequate for this purpose. The following recommendations are therefore made. Some are of a short-term nature and should be put into effect immediately; others need be adopted only if the long-term recommendations (see below) are accepted.

Table 13

AROMA CARDBOARD FACTORY

SUGGESTED ONE-SHIFT PAYROLL FOR FACTORY WORKERS

(NOV. 1967.)

Dept.	Grade 1	2	3	4	Total
Stocks-Cutters:					
Loading	-	-	-	3	3
Trucking & Unloading	-	-	-	2	2
Cutters:					
Cutting	-	-	-	2	2
Handling	-	-	-	2	2
Digesters:					
Chemicals	-	-	1	-	1
Filling	-	-	-	2	2
Emptying	-	-	1	-	1
Handling	-	-	-	1	1
Stock Prepn.:					
Screw-press	-	-	1	-	1
Handling	-	-	-	1	1
Pulpers	-	-	1	1	2
Refiners	-	1	-	-	1
Machines & Presses:					
Foreman	1	-	-	-	1
Sheet removal	-	-	8*	-	8
Washing	-	-	-	1	1
Handling	-	-	-	2	2
Driers:					
Foreman-mechanic	-	1	-	-	1
Feeding	-	-	-	2	2
Emptying	-	-	-	1	1
Finishing:					
Foreman	1	-	-	-	1
Calenders	-	-	2	2	4
Trimming	-	-	2	2	4
Packing	-	-	2	2	4
Totals	2	2	18	26	48

* Note. Assumes 4 machines only working. On heavy sheets, 3 men could serve 2 machines; total 6.

Table 14

AROMA CARDBOARD FACTORY

SUGGESTED ONE-SHIFT PAYROLL

FOR AUXILIARY SERVICES (NOV. 1967.)

Dept.	Grade 1	Grade 2	Grade 3	Grade 4	Total
Boilers	1	-	-	-	1
Electrician	1	-	-	-	1
Maintenance	1	2	2	2	7
Masons & Joiners	-	1	1	1	3
Watchmen					
Water	-	-	-	1	1
Houses (12 hr.)	-	-	-	1	1
Factory (12 hr.)	-	-	-	2	2
Reserve	-	-	-	1	1
Gardeners:					
Factory	-	-	-	2	2
Houses	-	-	-	1	1
Drivers	-	2	2	-	4
Messengers, Cleaners	-	-	-	2	2
Totals	3	5	5	13	26

Table 15

AROMA CARDBOARD FACTORY

SUGGESTED STAFF PAYROLL (NOV. 1967.)

Position	K/J	J	J/H	H	Total
General Manager	1	-	-	-	1
Works Manager	1	-	-	-	1
Chief Accountant	-	1	-	-	1
Clerks	-	1	1	-	1
Secretary	-	-	1	-	1
Laboratory	-	1	1	-	2
Technicians	-	2	-	-	2
Totals	2	5	3	-	9

(a) Running water should be supplied and, if the room at present used as a laboratory continues to be used also as a First-Aid room, then hot and cold running water are necessary.

(b) The existing weighing balance should be repaired and kept as a spare and a modern, rapid-action, single-pan balance, sensitive to 10 milligrams, obtained for routine use.

(c) The existing wetness testing apparatus (Schopper Riegler), drying oven, and ash furnace are satisfactory, although the last is redundant. The tensile strength tester is also redundant and in any case unsuitable. Additional testing apparatus required is as follows.

(i) A standard, dead-weight micrometer, with wide area testing surface.

(ii) A quadrant scale for the rapid determination of basis weights using large sheets.

(iii) Bending tester.

(iv) Rigidity tester.

(v) Volumetric analysis apparatus for the titration of alkali, etc.

(vi) Ph value measurement (colorimetric).

The above are minimum requirements. If however, the long-term recommendations are adopted, the following will also be required.

(i) Small scale digester.

(ii) Pulp evaluation equipment.

(iii) Tearing and folding strength testers.

(iv) Brightness tester.

(v) Ring-crush tester.

(vi) Tensile strength tester (standard type).

(vii) Water resistance tester.

(d) Control Methods. - The following routine laboratory tests should be made at least once per shift, unless otherwise stated. These are to be regarded as a short-term recommendation.

(i) Titration of caustic alkalinity in white liquor added to each digestor.

(ii) Titration of residual caustic alkalinity in waste liquors from each digestor.

(iii) Consistency test before No. 1 refiner.

(iv) Consistency test after screw press.

(v) Consistency test from the machine chest.

(vi) Ph value at machine chest.

(vii) Consistency test at machine head-box supply.

(viii) Moisture tests at take-off roll of each machine.

(ix) Moisture tests after each press.

(x) Moisture test at delivery end of dryer.

(xi) Moisture test after trimming.

(xii) Basis weight and caliper tests after second trimmer.

(xiii) Daily tests on the fibre contents of both effluents, i.e. from washings and machines, and black liquor.

The results should be recorded systematically, and deviations outside the range of acceptable figures should be notified at once to the foreman. Such ranges of figures can be drawn up when the mill is running on the new system.

12. Engineering

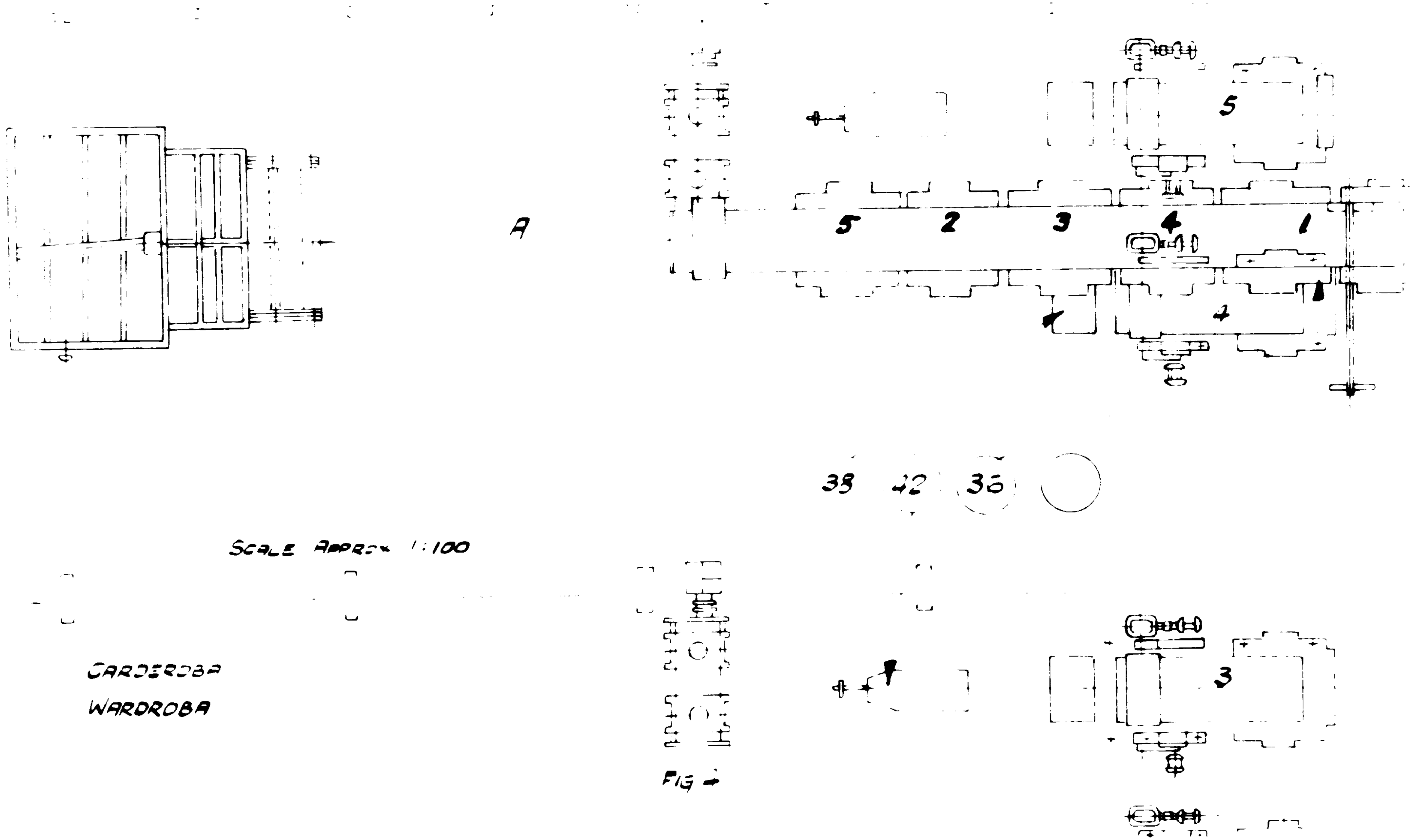
Existing outstanding maintenance should be brought up-to-date as soon as possible, and a system of preventive maintenance installed. This will involve making a list of all the routine maintenance operations, including lubrication and safety measures, showing the frequency with which they are to be carried out. The card system is convenient for this purpose, each entry being initialled by a responsible person as it is carried out. A check should be made every two weeks on safety measures such as guards, railings, fire precautions etc.

Long-Term Recommendations

It is apparent from Part IIIc and d, dealing with the product and its markets, that whatever the raw material used in this factory, the manufacture of low-grade cardboard by the process at present installed cannot possibly be economic in the present markets in the Sudan. It is therefore now suggested that means should be explored of manufacturing a higher-priced product having a much wider market. A case has already been made out for the manufacture of fluting, for corrugating medium, for the insides of corrugated cartons; for an imitation kraft paper to be used for common wrappings; and possibly, for a white-lined boxboard. An essential feature of such revised manufacture is continuous operation, i.e., producing the product in reel form; as distinct from the sheets manufactured at present. At the same time it is important that the machines can, if necessary, still operate on an intermittent basis, making sheets if required.

The system adopted should also be applicable to the manufacture of a wide range of products, namely from relatively thin substances of 75 g.s.m., up to the heaviest weights at present made, i.e., about 2,000 g.s.m. A third and very important consideration is of course, that all this should be achieved with a minimum of expense. A scheme is therefore put forward below which, it is believed, should achieve these objectives. It must be emphasised that this scheme is at present in a very preliminary stage, and that a detailed study of the machinery would need to be made by a paper machinery manufacturing engineer in order to advise just how the scheme would best be put into effect, what additional equipment is required, and what it would cost. The whole problem is an unusual one and so is the solution, but in my view it provides the only possible means of survival for the cardboard factory in its present form; it should therefore be pursued actively.

Briefly, the main change is to place the 5 existing machines on end together, as one continuous machine, immediately opposite the present drying machine. Fig. 4 shows how this arrangement would appear in its final state. The heavy lines show the new arrangement superimposed on the present lay-out (in fainter lines), and the faint and heavy numbers indicate the present and proposed positions of the machines, respectively. As an aid to clarity, Fig. 5 shows the present lay-out in this area of the vat house. No. 1 machine which has the double vat would comprise the first 2 vats of the new machine, and the other four would follow in succession as shown. The space between the end roll of the last machine (No. 5) and the entry to the dryer would be occupied by new equipment, i.e., two press rolls and drying cylinders; probably two pre-driers and one large Yankee dryer would be required, and the existing tunnel dryer could be utilised for finishing off this operation.



FIG

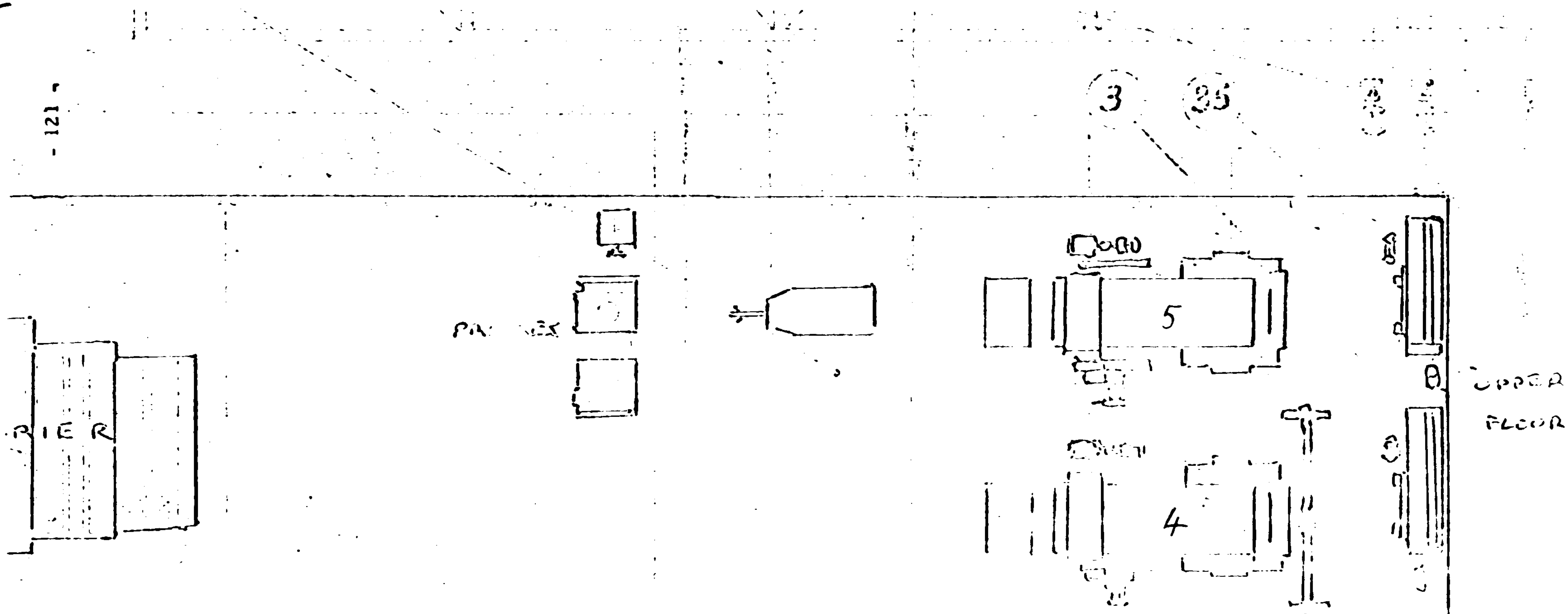


Fig 5.

As Fig. 4 shows, the space available for these additions (A) is adequate (approximately 7.5 metres), but this is a matter which has to be worked out in detail when proposals are available from paper machinery manufacturers. A certain amount of economy of space could be obtained by stacking the two presses, so that one is above the other instead of by its side.

Provision will have to be made to operate this machine in a variety of ways to ensure that the maximum range of papers and boards can be made. Thus:

(a) It could operate as at present making heavy millboard sheets. In this event the building-up roll would be retained and the sheets would be taken off by hand and dried in the tunnel dryer as at present. Only one vat would normally be used, but it may be possible to increase production by using two or more so that less revolutions of the final roll are required to obtain the desired thickness.

(b) Making a composite board of individual sheets, one from each vat, and taking them off the final vat machine over the drying cylinders, if they are not too thick.

(c) The machine would manufacture thin boards or relatively thick papers such as fluting medium and imitation kraft wrappers. In this event only a single layer would be required and therefore, it would be necessary to use only the last vat in the series (No. 5), the remainder being idle. The paper would then come off this vat, through the presses and over the cylinders (A), and would be reeled up at the entry or end of the tunnel dryer, as convenient.

(d) In yet another form of operation a composite type of board would be made, such as a lined boxboard of the type used for shoe boxes etc.; there is always a considerable demand for this product. This would necessitate making a board of medium thickness from local raw material, and lining it with a higher-grade paper which would have to be made from imported bleached or unbleached sulphite pulp. In this event the board base would be made up on the first two or three vats and the liner would be applied finally and separately by supplying one vat (say No. 5) with the requisite imported pulp. The composite board would emerge from the last vat, and be pressed, dried, and reeled up in the usual way.

It will be seen that such an arrangement should give an extremely versatile unit enabling any type of paper or board to be made (within the range imposed by the raw materials available), from relatively thick papers to the present heavy millboard.

It is of course appreciated that in substituting the 5 small units by 1 large unit, the overall production capacity is reduced. The only answer to this is to increase the speed of the machine. Tests were therefore carried out at the factory to ascertain the maximum speed at which the machines would run under present conditions, and this was found to be 30 metres per minute. It is possible that a higher speed is obtainable with alterations to the drive, and it is also possible the machine may not be able to form a sheet at much higher speeds. However, if one assumes 30 metres per minute as a maximum, and that it can then make a web of paper or board, 140 cm. wide, e.g., of corrugating medium of basis weight of about 130 gm. per square metre, it can be calculated that the machine would produce 8 tons in a 24-hour day.

This would be insufficient to show a profit, and it would be necessary to run higher substances in order to obtain approximately 13 tons per day. A board of basis weight 215 gm. per sq. metre being made on this machine at 30 metres per minute would yield over 13 tons per day. White-lined boxboard has an average substance of about 300 gm. per square metre, and it would be necessary to run partly on this, partly on fluting and possibly to some extent on heavy board to maintain the average production of 13.5 tons per day. Incidentally, white-lined boxboard is a highly-priced commodity, although of course a proportion of it is made from imported pulp.

The attached Certificate from Hehner & Cox Ltd. is a comparison of the basic properties of the 2-layer sheet of paper obtained in the Aroma mill trial with corresponding products used in the Sudan. The comments show that it offers promising results. Unfortunately it was not possible to remove a single layer sheet by hand.

Associated with the above major reconstruction, would be implementation of the short-term recommendations listed above, and this would help to reduce the overall production cost. Added to this would also be the improved technical control, which should reduce the amount of sub-standard paper made, the fibre losses, and the chemical requirements, etc.

HEHNER & COX, LTD.

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OUR REF. JG/PW/27689X

YOUR REF. SUD-052-SI

5th January, 1968

ANALYSIS OF 4 SAMPLES OF ......Paper.............

RECEIVED ON ...13th December, 1967

MARKED ....as under.........

SEALED ------------

	Aroma (Mill Trial)	Packaging House (fluting)	Blue Mill (fluting)	National Mill (wrapping)
Basis weight (g.s.m.)	154.9	127.1	121.9	76.8
Caliper (mil.)	13.6	11.0	9.0	5.8
Apparent specific gravity	0.45	0.46	0.53	0.52
Bursting strength (kg./sq.cm.)	2.2	1.26	0.56	0.92
Burst factor	2.23	2.20	1.88	1.92
Ash (%)	3.5	2.7	0.7	4.6
Fibre (approx.%)				
Mechanical wood	-	65	85	20
Chemical wood	15	25	15	60
Miscellaneous (waste)	-	10	-	20
Cotton stalks	85	-	-	-

Comment

Even when allowance is made for the heavier basis weight of the Aroma trial sheet, it is shown to have a higher bursting strength than the other 3 examined, and is equal to them in the other respects recorded above.

Insufficient material was available for tearing strength tests, but visual examination suggests that the Aroma paper is no worse than the others in this respect.

p.p. Hehner & Cox Limited.

Julius Grant.

United Nations,

Unless the paper or board can be dried completely on the new pre-dryers and Yankee cylinder of the main machine, it will have to be finished off in the existing tunnel dryer. Probably the ordinary papers (fluting and wrapping) can be so dried, but the lined boxboard and particularly the heavier boards will have to make use of the existing dryer. Tests carried out during my visit to the mill indicated that this ran at a speed of only 1.5 to 4.0 metres per minute according to the basis weight of the board dried (see Tables 2 and 3). If however, the pre-drying cylinders are used it could no doubt run at a much higher speed, even with boards. At the time of my visit the maximum speed of this machine which could be obtained was 8 metres per minute, but as described in Part III b, the condition of the wire made it risky to attempt to run it at a higher speed. In any case the PIV gear of the dryer drive was not working, so that the maximum speed obtainable could not be ascertained. There seems however, little doubt that by attention to the drive the speed of the dryer could be increased to 30 metres per minute, although precautions would have to be taken to prevent the wire wandering as at present.

The innovations and rearrangements indicated above would call for other modifications in the system. In the first place the 5 presses would not normally be required since the pressing would in most instances be carried out by press rolls on the machine. The arrangements for feeding pulp to the rearranged machine would also be simplified because only one unit would be involved. It would be necessary to instal better screening arrangements before the machine, as a higher quality product would have to be made, and this applies particularly to the vat (No. 5) which would make the white liner for the board, since the standard of cleanliness for this part of the unit would have to be particularly high. The present refining system would also have to be improved upon, and rearranged so that it could be used to deal either with the home-produced raw material or with the imported pulp. This might necessitate another small refiner of a more efficient type to enable the system to be used with complete flexibility. It would also be necessary to add sizing to the paper when this is being made and possibly also wet-strengthening agents. By the use of additives it is now possible to make high wet-strength millboard which withstands extreme climatic and transport conditions, and this commands a correspondingly higher price. Actually the original specification envisaged the use of rosin size, and this particular addition to the system is not a great problem. Certainly there will be no lack of space after the rearrangement of the machines.

A further advantage of this recommendation is that the labour force required for running the machine house and driers will be considerably reduced, as only one unit will exist and four machines and 5 presses are eliminated. The installation of calender stacks at the new reeling-up end at the end of the present dryer will eliminate the present hand-operated calenders. If these are followed by a separate unit for slitting and trimming the reel and cutting it into sheets, then the inefficient operation as carried out at present and the considerable amount of labour involved will be eliminated. Naturally, when the heavy boards are being made it will still be necessary to use a hand process as at present (with the improvements already suggested under Short-Term Recommendations) so that this equipment will have to remain on site in position. However, the labour required to operate it will be called into action only as required. It should be possible to operate the composite machine suggested with a maximum of 4 men per shift, once it is running smoothly.

Production Cost and Profitability

The above short and long-term recommendations are taken into account in compiling the cost sheets shown in Tables 16 and 17.

Table 16, shows a cost sheet drawn up on the assumption that the mill could make 4,000 tons per annum of fluting medium or wrappings. Table 17, shows a similar cost sheet based on 4,000 tons per annum of white-lined boxboard. For the purpose of the calculations, it has been assumed that the alterations involved would cost approximately £.70,000, and this has increased the depreciation and interest charges accordingly. It will be seen that, in the case of the fluting and wrappings, a profit of approximately £.8.6 per ton is estimated; and in the case of the white-lined boxboard the profit is approximately £.20 per ton. As already stated it will not be possible to run full time on fluting and make 4,000 tons per annum. However, subject to the assumptions made being correct, the mill should be able to make on an average approximately £.10 per ton profit, by manufacturing whatever

Table 16

COST SHEET

WRAPPINGS AND FLUTING

(TONS 4,000 P.A.)

	Item	Quantity	Unit Price	Cost p.a. (£.)
1.	Stalks	T. 7,333	£. 2.5	18,330
2.	Caustic soda	T. 587	£. 30.0	17,610
3.	Chemicals	T. 220	£. 25.0	5,500
4.	Water	792,000 cu. m.	£. 0.03	23,760
5.	Diesel oil	T. 2,000	£. 19.47	38,940
6.	Fuel oil	T. 3,000	£. 11.01	33,030
7.	Labour	200 men	-	36,000
8.	Management, etc.	-	-	10,000
9.	Maintenance) Materials)	-	-	8,000
10.	Standing charges	-	-	6,600
11.	Depreciation	£. 550,000	7.5%	41,250
12.	Interest	£. 550,000	5.0%	27,500
13.	Total			266,520
14.	Substandard paper	T. 400	£. 49.5	19,800
15.	Cost per annum			246,720
16.	Cost per ton saleable paper (dry basis)			£. 61.7
17.	Cost per ton saleable paper (air-dry)			£. 57.4
18.	Average selling price per ton (air-dry)			£. 66.0
19.	Profit per ton.			£. 8.6
20.	Profit per annum			£. 34,400

Notes.

1. Assumes 100% stalks and 60% yield (dry basis) at estimated price of castor stalks.

2. Assumes 8% on stalks at current price.

3. Assumes rosin/alum sizing and/or wet strengthening agent.

4. Assumes 180 cu. m. per ton of paper.

5, 6. Based on reasonable current practice and prices.

7. Based on one-shift recommendations (Table 13).

8. Allows for a highly-experienced executive.

9, 10. Based on present costs.

11, 12. Assumes £. 70,000 for cost of alterations, etc.

14. Assumes approximately 10% substandard paper valued at 75% of average selling price.

16. Is 15. divided by 4,000 tons.

17. Assumes that the paper as sold contains 7% moisture.

18. As deduced in Part IIId.

19. Difference between 18. and 17.

20. Is 19. multiplied by 4,000 tons.

Table 17

COST SHEET

WHITE-LINED BOXBOARD

(TONS 4,000 P.A.)

	Item	Quantity	Unit Price	Cost p.a. (£.)
1.	Stalks	T. 58,667	£. 2.5	14,667
2.	Wood pulp	T. 9,263	£. 60.0	55,578
3.	Caustic soda	T. 470	£. 30.0	14,100
4.	Chemicals	T. 15	£. 25.0	325
5.	Water	792,000 cu.m.	£. 0.03	23,760
6.	Diesel oil	£. 2,000	£. 19.47	38,940
7.	Fuel oil	£. 3,000	£. 11.01	33,030
8.	Labour	200 men	-	36,000
9.	Management, etc.	-	-	10,000
10.	Maintenance) Materials)	-	-	8,000
11.	Standing charges	-	-	6,600
12.	Depreciation	£. 550,000	7.5%	41,250
13.	Interest	£. 550,000	5.0%	27,500
14.	Total			309,750
15.	Substandard board	T. 400	£. 51	20,400
16.	Cost per annum			289,350
17.	Cost per ton saleable board (dry basis)			£. 72.3
18.	Cost per ton saleable board (air dry)			£. 65.1
19.	Average selling price per ton (air dry)			£. 85.0
20.	Profit per ton			£. 19.9
21.	Profit per annum			£. 79,600

Notes.

1. Assumes 80% stalks and 60% yield (dry basis) at estimated price of castor stalks.

2. Assumes 20% bleached coniferous sulphite pulp; 95% yield. Price based on current European prices plus freight.

3. Assumes 8% on stalks at current price.

4. Assumes adequate rosin/alum sizing.

5. Assumes 180 cu. m. per ton of board.

6, 7. Based on reasonable current practice and prices.

8. Based on one-shift recommendations (Table 13).

9. Allows for a highly-experienced executive.

10, 11. Based on present costs.

12, 13. Assumes £. 70,000 for cost of alterations, etc.

15. Assumes approximately 10% substandard board, valued at 60% of average selling price.

17. Is 16. divided by 4,000 tons.

18. Assumes that the board as sold contains 10% moisture.

19. As deduced in Part IIId.

20. Difference between 19 and 18.

is regarded as best for the market at the particular time.

The figures in the above tables indicate an estimated profit of £. 34,000 and £. 80,000 per annum if the factory makes 4,000 tons per annum of wrappings and fluting, or white lined boxboard, respectively. Since it is unlikely to be able to run on either entirely (for reasons given above), it seems reasonable to assume that it may make approximately 2,000 tons of each. In this event the profit would be approximately £. 50,000 per annum. Since the machine cannot produce the paper at the rate of 13 to 14 tons per day it will have to make the board to an extent which will enable this average to be maintained.

These cost sheets may have to be revised when the full effect on prices of the devaluation of Sterling is known. However, the major problem which determines the viability of the above recommendations is, always, the raw material position (at present undecided).

PART V

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

This Part of the Report is summarised in such a way that it can be read completely independently of the more technical and detailed matter dealt with in Parts II to IV. It is therefore intended primarily for those who desire to know of the general conclusions reached and the recommendations made, without needing to study the technical and other arguments on which they are based. It can therefore be read quite independently of the remainder of the Report.

Conclusions

1. This mill was built to make 4,000 tons per annum of millboard, and possibly other products of a rather better quality, using cotton stalks and possibly waste cement sacks. This was to be achieved by means of a pulp preparation plant for converting the cotton stalks into cellulose pulp, and 5 vat-type machines for converting the pulp into board.

2. As processed by the method envisaged, cotton stalks are an unsuitable material for making any but the very heavy and rigid types of board, since they lack flexibility. Their use is also limited by the dark colour of the resulting product.

3. On the whole and apart from a possible bottle-neck at times at the dryer, the capacity of the plant is adequate to produce the stated quantity of 4,000 tons per annum. However, for various reasons it has never been run at anything like full capacity. It has occasionally run 2 shifts per day, but now only 1 shift per day is worked.

(a) A principal contributory cause of this low production is the difficulty in selling the board made. The present customers complain of the quality of the boards, and particularly of bad cutting and variations in thickness and basis weight (weight per unit area). Its rigidity and brittleness restricts its use to cheap suitcases, bookbinding covers and handbag stiffeners. The low price is probably the only attraction, i.e., £.45 per ton, c.i.f. Khartoum.

4. Although the mill machinery is designed to produce 4,000 tons per annum, i.e., approximately 13.5 tons per day, the production for the 12 months ended June 1967, was in fact only approximately 190 tons of saleable board. The present production is said to be approximately 2 tons per day, but the proportion of substandard board which has to be re-pulped is considerable.

5. Despite the low price and the small output, it is very difficult to find a market for the mill's products. Quite apart from the fact that sales are hindered by the poor quality, a preliminary study of the statistics indicates that there cannot be a very large market in the Sudan for this particular type of board.

6. The difficulties are greatly aggravated by the fact that the Gash Agricultural Cooperation Board has decided to cease planting cotton in the region of the factory, thereby cutting off its principal raw material (cotton stalks). If this policy is put into effect it will mean that the mill will have no raw material of this nature from June, 1969 onwards. The possible use of castor stalks, which are being planted instead of cotton, is being actively pursued but there is no certainty of its success;

however, it is unlikely that castor will be any worse than cotton stalks, and if an improved variation of the present process is used, they might well be better.

7. Though the capacity of the mill is probably adequate, the machinery is in general crude and lacks the refinements necessary to obtain smooth and efficient running. This comment applies particularly to the vat board machines, of which there are 5, since these play an important part in producing the finished board. Details of the numerous respects in which improvements can be introduced are given in Part IV under Short-Term Recommendations; individually they are matters of detail, but collectively they determine the efficiency of the running of the mill and they therefore have a bearing on profitability.

8. An important deficiency is the absence of any proper system of technical control. A laboratory exists, but it is inadequately supplied with inferior material and, at the time of my visit, was almost useless. In any case there is no evidence that proper use was being made of such results as were obtained.

9. The mill has at present 103 mill workers operating on a morning shift only. It is therefore, considerably overmanned, and the immediate 25% reduction recommended could be made without affecting production.

10. The production position is further aggravated by a poor state of maintenance and frequent breakdowns. This appears to be due in large part to the difficulty of obtaining spares owing to the closing of the Suez Canal. However, it

is not due entirely to this, and much could be done immediately by a properly organised programme of preventive maintenance.

11. By using the figures in the mill records for the year ended June, 1967, a production cost has been calculated (Table 11). It shows a loss of over £.60,000 per annum, excluding interest charges.

12. Table 12 is a cost sheet based on present conditions, and shows the position assuming the mill is able at the present time to make the specified 4,000 tons of board per annum from cotton stalks and waste paper with only 10% of substandard paper. It will be seen that even in these optimistic circumstances the mill would lose about £.20,000 per annum, excluding interest charges.

Recommendations

1. The question of a substitute raw material for cotton stalks should be pursued actively. The first choice is castor plant stalks (Ricinus communis) which will be available in about March, 1968. Preliminary laboratory tests should be made in the first instance to indicate the best chemical and physical pulping conditions to be used. These should be followed by mill trials. In the meantime, tests, both in the laboratory and otherwise, should be made on other likely raw materials. A local bush is being tried out, but is unlikely to be successful. A more promising possibility is reeds from Kassala or even bagasse or kenaf stalks from Khash el Girba, assuming cheap transport facilities are available. In any case the best conditions for operating any of these should be based on a combination of laboratory and mill experiments, the first to demonstrate the best method of operation and the second to show

how it can be adapted to practical use in the existing mill. If after all there is any possibility of the continued use of cotton stalks, then there should be a reappraisal of the present method of processing so as to give a more flexible type of board. If however, cotton stalks are finished so far as the Gach area is concerned, then this point will not arise.

2. A large number of short-term recommendations are put forward. These cover every aspect of the mill work from the collection of the raw material to the despatch of the finished board. Put into effect they should result in material economies resulting from purely operational procedures, such as handling the raw material, saving fibre, recovery of or otherwise reducing chemical costs, improving the stock preparation, improving pressing and drying, and eliminating the principal customer complaints of bad trimming and non-uniformity of properties. Most of these recommendations can be put into effect without delay, and at little cost.

3. The labour situation should be examined closely. Suggestions have already been put forward as to how the mill labour force can be reduced from the present 103 men to by about 25%. It is believed that this can be done without detriment to present operations.

4. There is at present no measure of technical control. This should be introduced immediately by repairing broken equipment in the laboratory, and installing the additional instruments repaired for testing. These are enumerated in Part IV. Most important of all, arrangements should be made to ensure that use is made of the results obtained, as distinct from merely recording them as has been done in the past.

5. The overall maintenance of the mill should be brought up-to-date and kept thus by a index card system of planned preventive maintenance.

6. The above are all short-term recommendations, and are not likely to improve the overall financial position of the mill very considerably. They should however, serve to reduce the losses. The real solution to the problem of the Aroma Cardboard Factory must of necessity be a long-term one. It is therefore suggested that the mill abandons entirely or almost entirely the manufacture of cardboard in sheets, and makes provision for manufacturing not only this product but also a fairly wide range of papers and boards as a continuous web which may be reeled up. This would enable the factory to enter a far wider market than at present, and there should be no difficulty in selling 4,000 tons per annum.

The type of product that would be made would range from cheap brown wrappings and the inside material (fluting) used in making corrugated cartons, to boxboard, and in particular the better quality of white lined boxboard as used for shoe boxes, etc. In these circumstances it is even possible that a low grade of carton could be made. This of course, would entail special additional machinery which has not been taken into account, but it might be suitable for some of the products sent out by the factories of the Industrial Development Corporation, e.g., the Onion Drying Factory at Kassala. However, not allowing for this, the above products could easily be absorbed by the existing trade in Khartoum and elsewhere. It is therefore recommended that this possibility be explored on the lines set out in the above Report.

7. In order to implement the above, it is recommended that consideration be given to the re-arrangement of the 5 existing vat machines to form one long continuous machine. This would be linked with the present tunnel dryer by means of press rolls and preliminary drying cylinders, so that the paper or board would emerge from the outlet end of the present dryer as a continuous roll. The present handling of it in sheet form, which involves a considerable amount of labour and waste, would be eliminated. This would not preclude the existing types of board from being made as at present, but owing to their low price they would be made only to fill up the mill if other orders were not available, or to built up tonnage. A preliminary study of the conditions of the mill indicate that the alterations outlined above are a distinct possibility (see Fig. 4). However, they need to be studied in greater detail, in particular by an expert on paper and board machinery manufacture, who can deal with the important problem of converting the 5 intermittent vats into one continuous machine at the lowest cost.

8. In order to make the white-lined boxboard it will be necessary to import a certain amount of bleached or unbleached sulphite pulp made from coniferous wood, since this is not available in the Sudan. The amount involved is relatively small, probably 10 to 15% of the total annual production, but its use would enable a product of far higher quality (and therefore selling price) to be made.

9. Tables 16 and 17 are production cost sheets showing the estimated results of making 4,000 tons per annum of either wrapping or fluting paper or else white-lined boxboard. They take into account all the recommended improvements put forward in this Report. These represent the two extremes likely to be manufactured. Actually it will not be possible to make 4,000 tons of the former because the capacity of the single machine will be inadequate. However, the capacity should be adequate to give the requisite output making partly the lighter type and partly the heavier type of product.

The figures in the above tables indicate an estimated profit of £.34,000 and £.80,000 per annum if the factory makes 4,000 tons per annum of wrappings and fluting, or white-lined boxboard, respectively. Since it is unlikely to be able to run on either entirely (for reasons given above), it seems reasonable to assume that it may make approximately 2,000 tons of each. In this event the profit would be approximately £.50,000 per annum. Since the machine cannot produce the paper at the rate of 13 to 14 tons per day, it will have to make the board to an extent which will enable this average to be maintained.

These cost sheets may have to be revised when the full effect on prices of the devaluation of Sterling is known. However, the major problem which determines the viability of the above recommendations is, always, the raw material position (at present undecided).

10. In addition to putting the mill on a profitable basis, this recommendation will also save foreign currency, because all the products of this nature are at present imported. Probably about 400 tons of wood pulp will have to be imported, but this will still save currency since it is at present being imported in the form of paper, which, is more expensive. The factory will however, come into competition so far as wrappings are concerned with the mill operated by the National Paper Industries Ltd., in Khartoum (see Appendix), assuming that this starts up again successfully.

11. It is believed that the above long-term suggestion offers the only salvation for the Aroma Cardboard Factory. If for any reason it cannot be implemented, and if moreover it is not possible to find a suitable local raw material to be used at an economical price, then the factory cannot show a profit; and if interest and depreciation charges are taken into account the loss must inevitably be considerable. Unless such a loss is to be tolerated for other reasons (e.g., giving employment), then the only alternative is to shut the mill. In this event the use of the equipment elsewhere in the Sudan might be considered, as its selling value outside the Sudan would be extremely small. There is a suggestion that a study be made of the possibility of a pulp and paper industry for the Sudan as a whole. If such a study is made, the incorporation of the existing equipment from the Aroma factory would be logical although, as already pointed out, it is of very limited use while arranged to produce sheets instead of reels of paper or board.

12. As an approximate and preliminary estimate it is felt that the major alterations recommended above would cost approximately £.70,000. If it is decided to proceed with the recommendations made, it may well be that the implementation of this work by the Yugoslavian Government could be a means of settling the present controversial position. In my view the responsibility for the present losses depends largely on the lack of a proper Feasibility Study for the project in the first instance. This led to an unsuitable material and process being chosen, and an end-product having a very limited market. This has been aggravated by the limitations of the machinery installed and by a low standard of efficiency in running the mill. It seems to be in the interest of both sides to bring this matter to a successful and amicable conclusion and if the recommendations of this Report are approved, then they may well provide means to reach a financial compromise. It should however, be emphasised that any plans for the reconstruction of the factory and the implementation of such plans should be approved by the Government of the Sudan or by their accredited representatives before the mill is accepted.

January, 1968. Julius Grant

PART VI

APPENDIX

NATIONAL PAPERS INDUSTRIES LTD.

Introduction

A report on the above mill has been made at the request of the Sudan Industrial Research Institute and the Sudan Industrial Bank.

For this purpose the mill was visited on the 30th November, 1967; a previous brief visit had already been made in the course of the main study, on 16th November, 1967.

A thorough report on this mill has also previously been made by a Research Institute team, under the leadership of Mr. H. J. W. Smith, and this was made available to me.

On the occasion of my visit the following were also present:

Mr. H. J. W. Smith, Sudan Industrial Research Institute.

Mr. Tagelsir Mohamed, Engineer, Sudan Industrial Bank.

Mr. Shamam Omer, Economist, Sudan Industrial Bank.

Mr. A. Nicola, Managing Director.

Mr. A. John, Director.

The general position is that the Bank has supplied to a private company, finance for building and running this factory. It was built to produce mainly grey wrappings and fluting paper, and to start-up in 1963. Up to about 5 months before my visit (it was said) receipts and costs were just about in balance, but the production of the factory was handicapped by inadequate raw materials, and the Company has been unable to meet its interest charges and repayments of capital to the Bank. An additional loan has been requested in order to put into operation certain improvements and developments, which it is claimed, will enable production to be increased and a greater profit made.

As stated, the mill was built to make grey wrappings and fluting papers, but its principal product at the time in question was a 30-160 (mostly 75) grams per square metre imitation kraft wrapping made from local waste. Originally, the mill had a certain amount of protection, through the 1956 Concessions Act, against imports of similar materials. For some 3 years, however, it had lacked adequate protection. The capacity was said to be 90 tons per month, but it was believed that this could be doubled for an investment of about £.18,000.

During the first year, difficulty was also experienced with effluent disposal. The mill had run for two 12-hour shifts per day, making wrappings of the poorer grades of which there is said to be a big consumption in Khartoum; these correspond with a rather low-grade of imitation kraft, of no great strength.

In approximately May, 1967, trouble was experienced with the main boiler plant owing to the fact that it was allowed to run dry. The boiler collapsed and has had to be removed, and it will shortly be replaced.

The Bank is understandably worried about the future of the mill, especially as they are being asked for more money in order to put it on a profitable basis. The functioning of the mill also has some bearing on the Aroma Cardboard Factory problem, partly because it is a potential user of the Aroma pulp, a matter dealt with in the main Report (Part III); and partly because it manufactures grey board and fluting. In the latter connection therefore, it could well be a competitor of the Aroma factory if the long-term recommendations made in the present Report are put into effect.

My terms of reference for this Study can be summarised as follows. I was asked to comment on the following points: -

1. The condition of the machinery; to what extent is it able to produce, or does it require alteration?

2. The reason for the accident to the boiler, and what can be done to prevent its recurrence.

3. Raw materials and other supplies.

4. The quality of the product.

5. Comments on costing.

6. The value of the plant.

7. The possible use of Aroma pulp in the plant.

It should be made clear that the mill was not running during either of my visits, and as stated, it had been shut for 5 months. Also the wet end and felt system of the paper machine had been dismantled.

Raw Materials

An attempt to solve the problem of shortage of raw material (waste paper) had been made by importing mechanical wood pulp. This however, attracted a duty of 40%, but this has recently been reduced to 10%. However, pulp had been stored at the Customs in Port Sudan for some 2 years awaiting this decision, and big demurrage charges had been incurred.

The raw materials are normally mixed waste papers of all kinds, including cement sacks. They are obtained through a contractor and are roughly graded but not sorted in the usual sense of the word. The price ranges from £.9 to £.40 per ton according to grade, but the contents of any one particular grade are very variable. Most of that used however, seems to be priced at £.9 per ton. Imported mechanical wood pulp costs £.33 per ton. Formerly, used newspapers were imported at £.23 per ton, but as they are licensed on the basis of import for direct use as wrappers, the price is too high for them to be used as raw material at the factory. During the closed period of the mill, waste paper has been collected, and there is now an accumulation of 500 to 600 tons.

An attempt was made shortly before the mill closed to use the cotton stalk pulp from the Aroma Cardboard Factory. It gave fair results in a furnish of 25% Aroma pulp, 25% local waste papers and 50% used cement sacks, but its short fibre was a drawback. Probably 15% could be used without detriment in this respect, but the value to the paper mill was said to be no more than that of the local waste paper; this [illegible] question.

Brief Description of Mill

The waste paper is treated in 2 kollergangs, capacity 200 to 300 kgm. each, on a 1 hour time cycle. The pulp is then transferred to storage tanks with water; and thence by gravity to 2 hollanders fitted with iron bars. The make of these is not known, but they appear to be Italian in origin.

Each has a capacity of 150 kgm. and the operating time is 0.5 - 1 hour. A vertical coarse grid is used to trap strings, etc. From the hollanders the pulp is dropped into a chest, but pump troubles have been experienced due to the coarse impurities present, and the pump originally installed has therefore been replaced by a home-made bucket feed. The pulp thus reaches the headbox, where alum is added (but no rosin) and if a kraft type of paper is being made, a brown dye is added here also.

The prepared pulp then passes through a flat machine screen with 4 pairs of plates, all in very bad condition due to clumsy efforts to open up the holes and increase the capacity. It was said however, that only the 2 best of the 4 plates were used. The machine has a simple headbox, breastbox and slice, with 4 suction boxes (vacuum, 4.5). There is one plain felted couch, but the rubber roll is said to be unsatisfactory owing to warping by heat. Then follows one straight plain press, and one reversing press with stonite top rolls and rubber bottom rolls. There are then 4 pre-dryers (pressure, 2.5 atm.), 3 down and 1 up, all badly scored. They are cleaned by means of a poor type of home-made doctor.

The single Yankee cylinder which follows is in fair condition considering the material being used. There is a spar-type reel-up, and the dry paper is cut off in wads as required and guillotined to size along two edges. This was found by the Research Institute team formerly investigating the factory to be inaccurate and wasteful, because the sheets coming from the bottom and top of the reel up are of different sizes.

The drive has a Swiss-made speed controller, which was said to be too complicated for use, and this has been changed to a pulley method of changing speeds.

It is believed that production could be doubled by putting in 2 or 3 more drying cylinders. There is adequate room for these, especially as there is a long run between the reversing press and the first existing cylinder. The maximum possible speed of the machine drive is 120 metres per minute. A hydrapulper is also suggested as a means of dealing with the waste paper and broke.

Water is obtained from an 800-ft. deep well and the effluent is allowed to sediment in elaborate pits which permit the recovery of a certain amount of the waste water and fibre. However, from time to time and especially when coloured papers are being made, it is necessary to shut the system for 1 day per week (usually Fridays) in order to change the water.

The boiler accident was due to the boiler-man falling asleep, and the boiler being allowed to go dry. When water was added to the hot boiler, it collapsed. A new boiler is on order from Italy and should be working in about 3 months.

The production was said to be 3.5 to 4.5 tons per day, and the broke (substandard paper) amounted to approximately 1 ton per day. The machine ran at 40 to 50 metres per minute, and makes a reel 150 cm. trim. It is under the above conditions that the mill was said to have been breaking even.

Labour

The staff has been retained, together with the principal operatives, during the shut period, in anticipation of the start-up again. The mill works 6 days per week, and it is assumed that there are 20 working hours per 24-hour day, to allow for stops or rests, etc. The payroll totals 75, but the quality of the labour is regarded as poor.

Table 1 lists the labour payroll at the time of the shutdown (per shift unless otherwise stated).

Table 1

Handling waste	5
Kollergangs	2 to 3
Hollander	1
Chest etc.	1
Screen	1
Wire end	1
Press part	2
Dry end and reel	5
Guillotine	2
Sorting (girls)	5 per day
(boys)	2 per day
Packing	4-5 per day
Boiler	2
Electrical	2
Foremen	1
Assistant foremen	2
Watchman	1
Carpenter	1 per day
Waste paper collection (by outside contractor but specially for mill)	5 per day
Drivers	3 per day
Maintenance workers	3 per day
Wages paid:	
Unskilled	£.0.26 to £.0.35 per day plus overtime.
Skilled	£.0.40 to £.0.45 per day plus overtime.

Fuel and Power.

Boiler requirements	220 gallons of fuel oil per shift.
Electricity (which is purchased)	365 kw. hours per ton, equivalent to £.4 to £.5 per ton of product made.

Costs, Selling Prices, etc.

Selling prices vary according to the products made. Thus:

Imitation kraft	£.60 to £.65 per ton, (£.75 before trade discounts, as there are several middle men).
Corrugating medium (fluting)	£.55 to £.60 per ton.
Other products	£.85 per ton.

For the purpose of the investigation carried out by the Research Institute, the average selling price was taken at £.74 per ton.

As already stated, the Research Institute has already made a thorough study of this problem. A 48-hour closely controlled trial run was made, and in consequence, the following production cost sheet was drawn up (Table 2). The paper produced was weighed, and the other consumables were measured where possible; in other cases average values based on the 6 months ended December 1966 were used in the calculations.

Table 2

	Total cost (£.)
Raw materials at £.9.0 per ton	85.9
Wages (70 men)	76.9
Fuel oil	37.9
Electricity (2,570 kw.)	32.4
Packing	4.2
Salaries etc. and administration	38.2
Vehicles	21.5
Repairs to plant	14.2
Spares	37.3
Sanitary	0.2
Electrical repairs	1.4
Sales expenses	3.5
Medical	0.1
Transport	1.6
Tools	0.2
Land	4.0
Depreciation:	
Building	32.5
Plant and machinery	111.9
Office	1.3
Interest (Sudan Industrial Bank)	26.6
Private loan	10.9
Total	542.7
Production	7,350 kgm.
Cost per ton	£.73.8
Selling price per ton	£.74.0

Similar data from the Company's records (which I did not see) for the period 1st July to 31st December, 1966, were said to give a total production cost of £.47,056 for a production of 495 tons; i.e., equivalent to a total production cost of about £.95 per ton.

Conclusions and Recommendations

1. Generally speaking, the condition of the machinery is poor. If the plant was new at the time of installation in 1963, then it has obviously been very badly maintained. There is much evidence of ingenious expediency in overcoming mechanical difficulties, but these are of a crude and precarious nature and do not lead to efficiency. An example is the effluent treatment plant which must have been expensive, whereas something much simpler and cheaper would probably have done as well. Another example is the bucket-type pulp feed which is not the real answer to the difficulty of handling the pulp by pump. Other examples abound throughout the mill. If expense were no object, one could, of course, make many valid suggestions for improving the efficiency and production of this mill. There is no doubt however, that two of the main improvements suggested by the Directors are sound, namely the use of a hydrapulper to deal with the waste paper; and increasing the drying capacity of the paper machine, which means faster running. Both would increase overall capacity.

2. The production cost sheet evaluated independently by the Research Institute suggests that, under present conditions, the mill could just about break even. The figures for the last full 6 months of running are less assuring.

3. However, I believe that under substantially the same operating conditions as at present, but with increased efficiency, the factory could be run to manufacture more profitably. A production cost sheet illustrating this is set out in Table 3, with explanatory notes thereon. The present selling price of £.74 per ton shows a profit of £.17.1 per ton, equivalent to £.25,600 per annum, assuming a production of 1,500 tons per annum. It will be noted that the principal differences between this cost sheet and those already produced are in the amount of substandard paper made and the labour charges. The proposed system is based on 3-shift working, rather than two 12-hour shifts, and it is believed that this can be done at no extra cost but will result in greater efficiency. Assuming that outstanding maintenance is brought up-to-date and the mill is run efficiently, then the substandard paper should not exceed 5% of the gross production on this class of paper.

The minimum improvements necessary to obtain a production of 1,500 tons per annum, assuming that adequate waste paper is obtainable at £.12 per ton, are as follows.

(a) Improved screening between the hollanders and chests, enabling the pulp to be pumped to the machine.

(b) Improved machine screens.

(c) Installation of a slitter and cutter. The above might be carried out for approximately £.7,000.

4. Raw materials present a considerable problem. So far as concerns the start-up of the mill when the boiler is re-installed, production seems to be assured for a time by the large accumulation of waste papers which has been made

while the mill has been closed. This was about 600 tons at the time of my visit, and will probably be more at the time of the start up. If adequate supplies of waste paper cannot be obtained from the Sudan, then it is difficult to see where satisfactory supplies can come from. The Aroma cotton stalk pulp is not very satisfactory, and in any case cannot be bought at a price which will enable the Aroma Cardboard Factory to survive (see Part IV).

The importation of mechanical wood pulp has been considered but if this is done on any scale under present conditions the profit margin will be reduced, since mechanical wood costs £. 33 per ton, as against waste papers at £. 12 per ton (or £. 15 per ton on an equivalent yield basis). Table 5 attempts to forecast the result of using 50% each of waste papers and mechanical wood pulp. The profit per ton is reduced to £.6.7 and the annual profit to £. 10,050, but the mill would probably run with less trouble and the quality of the product would be improved.

5. So far as waste paper is concerned, I suggest that its collection is contracted out, instead of being carried out by the mill. This may be more costly, but experience has found that it is likely to bring in larger supplies. For this reason £. 12 per ton has been allowed for the waste paper cost in the calculations, instead of £.9 per ton as at present. It is apparent from the production cost sheet Table 3 that an even higher price than this could be paid for specially good grades.

Table 3

PRODUCTION COST

PRESENT OPERATING CONDITIONS - 1,500 T.P.A.

(WASTE PAPER)

	Item	Quantity	Unit Cost	Cost p.a. £.
1.	Waste papers	T.2,000	£.12,000	£.24,000
2.	Fuel and electricity	see Notes		13,500
3.	Labour	66 men	see Notes	7,200
4.	Management and office	see Notes		5,000
5.	Maintenance materials	see Notes		4,000
6.	Standing charges	see Notes		3,000
7.	Depreciation	£.209,000	7.5%	15,700
8.	Interest	£.209,000	5.0%	10,500
9.	Total			82,900
10.	Substandard paper	T.75	£.20	1,500
11.	Total cost			81,400
12.	Cost per ton of product			£.54.2
13.	Packing			0.8
14.	Selling costs			1.9
15.	Cost ex mill			£.56.9
16.	Selling price			£.74.0
17.	Profit per ton			£.17.1
18.	Profit per annum			£.25,650

Notes.

1. Assumes 80% yield and 5% substandard paper.

2. Based on the equivalent of 0.75 tons of fuel oil per ton of product at £.12.000 per ton delivered.

3. See Table 4.

4. Provides for an experienced (ex-patriate) paper maker.

5, 6. Based on existing figures.

7. The sum used is made up as follows (from records)

Buildings	£. 57,634
Plant and machinery	141,020
Office	1,620
Miscellaneous	1,500
	201,774
New equipment (say)	7,226
Total	£.209,000

8. See 7.

10. Assumes that the repulping value of the 5% of substandard paper is £.20 per ton.

13. A customary figure.

14. Assumes 2.5% of selling price.

16. From mill records.

17. The difference between 16 and 15.

18. Is 17 x T. 1,500.

Table 4

SUGGESTED LABOUR FORCE

3-SHIFTS, 1,500 T.P.A.

Work	Shifts	Per Shift	Total man-shifts
Handling waste	3	3	9
Kollergangs	3	2	6
Chests etc.	3	1	3
Screens, etc.	3	1	3
Paper machine	3	3	9
Guillotine	3	2	6
Sorters (girls)	1	4	4
Boys	1	2	2
Packing	3	1	3
Foremen	3	1	3
Watchmen	3	1	3
Carpenter	1	1	1
Drivers	1	2	2
Boiler house	3	2	6
Electrical	1	2	2
Maintenance	1	2	2
	2	1	2
Total			66

Rates (per day):

Unskilled	£.0.260 - 0.350
Skilled	£.0.400 - 0.450

Assume

Unskilled	44 at £.0.320 =	£.14.080
Skilled	22 at £.0.440 =	£. 9.680
Total		£.23.760
Total per annum		£.7,128

Table 5

PRODUCTION COST

PRESENT OPERATING CONDITIONS 1,500 T.P.A.

(50% WASTE PAPER AND MECHANICAL PULP)

	Item	Quantity	Unit Costs	Cost p.a. £.
1.	Waste papers	T. 1,000	£. 12	12,000
2.	Mechanical wood pulp	T. 833	£. 33	27,500
3.	Fuel and electricity	see Table 3		13,500
4.	Labour	see Table 3		7,200
5.	Management and office	see Table 3		5,000
6.	Maintenance and materials	see Table 3		4,000
7.	Standing charges	see Table 3		3,000
8.	Depreciation	£. 209,000	7.5%	15,700
9.	Interest	£. 209,000	5.0%	10,500
10.	Packing	see Table 3		1,200
11.	Total			99,600
12.	Substandard paper	T. 75	£. 20	1,500
13.	Total cost			98,100
14.	Production Cost per ton ex mill			£. 65.4
15.	Selling costs per ton			£. 1.9
16.	Total cost per ton			£. 67.3
17.	Selling price per ton			£. 74.0
18.	Profit per ton			6.7
19.	Profit per annum			£. 10,050

Notes.

1. Assumes 80% yield and 5% substandard paper.
2. Assumes 95% yield and 5% substandard paper.

6. As usual in such cases the depreciation and interest charges are large items of the total cost of the product at the mill and therefore, the real avenue to profits is in increased production. Under present conditions it seems that a production higher than 5 tons per day, i.e., 1,500 tons per annum, is unlikely. Further money must be spent to ensure any increase, and the sum of £.18,000 has been suggested. Major items of improvement which will affect quality and/or production are as follows.

(a) Installation of a hydrapulper and screening system instead of the kollergangs. The existing hollanders can be used, although they are not very efficient.

(b) New screens for the machine.

(c) Certain improvements at the wet end of the machine.

(d) Additional drying cylinders.

(e) A proper reel-up at the end of the paper machine, with combined slitter and cutter, to eliminate the cutting up of the sheets by hand and guillotining. This will save labour and improve both quality and production.

(f) Installation of a saveall to economise fibre, and possibly to re-use water.

(g) General overhaul of plant and machinery and organisation of a proper maintenance system.

(h) There may be other items of expenditure which are not apparent while the machinery is stationary.

It is unlikely however, that all of the above could be carried for £.18,000; £.30,000 is probably a more likely sum, and this is used in the calculations of Table 6.

Table 6

PRODUCTION COST

SUGGESTED OPERATING CONDITIONS 3,000 T.P.A.

	Item	Quantity	Unit Cost	Cost p.a. £.
1.	Waste papers	T.2,000	£.12	£.24,000
2.	Mechanical wood pulp	T.1,666	£.33	55,000
3.	Fuel and electricity			27,000
4.	Labour		3	12,000
5.	Management and office			6,000
6.	Maintenance materials			8,000
7.	Standing charges			3,000
8.	Depreciation	£.230,000	7.5%	17,300
9.	Interest	£.230,000	5.0%	11,500
10.	Total			163,800
11.	Substandard paper	T.150	£.20	3,000
12.	Total cost			160,800
13.	Cost per ton of product			£.53.6
14.	Packing			0.8
15.	Selling costs			1.9
16.	Cost ex mill			£.56.3
17.	Selling price			74.0
18.	Profit per ton			17.7
19.	Profit per annum			£.53,100

Notes

8, 9. Allow approximately £.30,000 for new equipment.

All the other figures are based on those of Tables 3 and 4.

7. The production cost sheet, Table 6, shows the effect of doubling the production (to T. 3,000 per annum) at the present selling price, assuming that an additional £.30,000 is spent in order to make this increased production possible. The raw material position is dealt with by the assumption that 50% of mechanical wood pulp is imported and included in the composition of the boards.

8. In addition to all the above, greatly improved management and supervision is called for. The production cost sheets given above include for the services of an experienced papermaker, who will probably have to be brought from abroad. With every respect to Mr. Nicola, I regard this as extremely important. They also assume that outstanding items of maintenance and repair will be dealt with, so that the mill starts up again with only routine maintenance to contend with.

9. When the boiler is reinstated it should be fitted with an automatic device which operates both a sound and light alarm in the event of the water level running low.

10. I was asked to comment on the present monetary value of the plant. I think that its depreciated book value, is a fair assessment of its present worth on site. If however, it is intended to dismantle the plant and sell it on the open market then the amount to be expected from the sale would be very much less. Indeed much of the plant would be worth little more than scrap under these conditions. If dismantling the plant is contemplated this might be considered in the context of any future developments in the papermaking industry in the Sudan. Bound up with this would also be the future of the Aroma Cardboard Factory. Selling the plant in its dismantled condition

is only likely to fetch anything like the present written-down value if the plant is used in the Sudan, or for some purpose where the low cost of the secondhand machinery compensates for its old-fashioned design and low productivity. In any case a good deal of money will have to be spent on the machinery in the re-erection process.

11. Actually, the least unsatisfactory way out of the present dilemma appears to be to endeavour to run the mill much as at present, but with the minimum improvements suggested, so as to aim at a production of 1,500 tons per annum. With efficient running the factory should be in a position to make a profit, and in the course of a few years, the additional expenditure required to double the capacity of the mill can be made available with confidence. I do however, again emphasise the importance of proper supervision by an experienced papermaker.

12. Finally I must also again emphasise the fact that I did not see the mill running and, in consequence points which may have been disclosed by its operation may have escaped me; these could affect the above recommendations. I would also stress that the above calculations are necessarily approximate, and are based on data given to me verbally.

We regret that some of the pages in the microfiche copy of this report may not be up to the proper legibility standards, even though the best possible copy was used for preparing the master fiche.

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