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ESTABLISHMENT OF THE ARAB REGIONAL
PACKAGING CENTRE

DP|RAB|83|020|11-71

Technical report: Manufacture of corrugated board and boxes*

Prepared for the Governments of Sudan and Iraq
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of Sture V. Ostlund,
consultant in the manufacturing of corrugated board and boxes

Backstopping officer: J. Belo, Agro-based Industries Branch

United Nations Industrial Development Organization
Vienna

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A. INTRODUCTION

The Arab Industrial Development Organization in its capacity as an implementing agency for the Arab Governments and UNIDO as an executing agency for the United Nations Development Programme, are jointly carrying out a project with the aim to establish an Arab Regional Packaging Centre (ARPAC).

For this purpose the Moroccan Packaging Institute (Institut Marocain de l'Emballage et du Conditionnement, IMEC) is undertaking an extension to and up-grading of some important capacities in order to be converted into ARPAC, and other project activities are taken place simultaneously in selected countries of the Arab Region.

The main objectives of this special mission consist of training of Arab Industrial Engineers and technicians in corrugating plants in Sudan and Iraq.

B. TERMS OF REFERENCE

The mission was carried out according to the Job Description for Project DP/RAB/83/020/11-71/31.7.E
The terms of reference were :

1) Study ways of developing production of corrugated boxes with authorities concerned in Sudan and Iraq.

2) Determine technical problems related to industrial aspects such as production, product adaptation, quality control, training and maintenance.

3) Elaborate technical specifications in the field of corrugated board packaging and suggest ways to improve industrial plants.

C. CONDUCT OF THE MISSION

The mission was carried out from 14 September to 15 November 1986 according to following activities :

15 Sept.	Briefing in UNIDO Vienna
17-19 Sept.	Briefing in IMEC Casa
20 Sept-11 Oct	Field mission Khartoum - Sudan
12 Oct -30 Oct	Field mission Baghdad - Iraq
2 - 13 Nov.	Final drafting of the mission report and debriefing IMEC
14 - 15 Nov.	Debriefing in UNIDO Vienna

Main contacts in Sudan

Blue Nile Packaging

Mr Saed Ayoub El Gaddal : General Manager
Mr Mohamed Mahmud Abd El Hafiez : Maintenance Manager

The Packaging House

Mr Babiker Ahmed Abdalla : General Manager
Mr Mike Sherlock : Technical Adviser

Sudanese Kuwaiti Packaging

Mr Mohamed Abdalla Shulgami : Technical Manager

Main contact in Iraq :

Iraqi Company for Carton Manufacturing (ICCM)

Mrs B. Al Dhahir	:	General Manager
Mr Faris Baher Omar	:	Technical Manager
Mr ISSA Mohammed KADHIM	:	Production Manager
Mr Suhail J. Toma	:	Maintenance Manager
Mr Adiel Mamama	:	Quality Manager

D. OBSERVATIONS

Due to the short duration of the missions in both countries it was difficult to conduct practical demonstrations of the production machines capability, specially in Sudan where shortage, raw material and spareparts are big problems for the corrugated board manufacturers due to the lack of foreign currency. The situation in Iraq was completely different due to "over filled order book" it was not possible to stop the machines and make practical demonstrations. However, the consultant was able to give practical hints and conduct seminars for the production people.
Following observations were made :

S U D A N

The consultant spent most of his time with the Government owned corrugating plant, Blue Nile Packaging. There is no doubt about the fact that this company is in a great need of assistance. A part from lack of raw material and spareparts Blue Nile Packaging is facing serious problems, such as lack of modern equipments and basic know-how of production techniques. Most of the time, during the consultants' mission in Sudan, the machines were not in operation due to lack of raw material, spareparts and breakdowns. The management showed great interest in learning about new machinery and modern production know-how, and most of the consultants' time was spent in giving recommendations to the maintenance and production people. Unfortunately the Production Manager, Mr El Tayeb Mohamed El Karar was an leave and could not attend to the sessions given by the consultant. An outline of the findings and the recommendations for Blue Nile Packaging is presented separately(Page 5). To some extent recommendations are also given for some other corrugated board manufacturers like The Packaging House and Sudanese Kuwaiti Packaging. ...

I R A Q

The consultant spent the entire mission with the 51% owned Government Corrugated board plant ICCM (Iraqi Company for Carton Manufacturing). This company has been in operation for three years and is fully equipped with modern machinery for manufacturing of corrugated boxes. The factory building is of extremely good quality and the lay-out of the machines is almost perfect. The management as well as the workers are fully capable to make this factory comparable with any modern corrugated box plant in the rest of the world.
However, the consultant gave hints and recommendations regarding production technology and production-planning and conducted a seminar for the production and quality control management. It is the consultants opinion that there is a slight lack of production know-how, production-planning and basic knowledge of starch-steam and paper technology.
An outline of the findings and the recommendations for ICCM is presented separately (Page 11).

During the mission in Sudan as well Iraq the consultant spent a great deal of time to make corrugator programmes in order to show how to minimize the trim waste reduce running meters and number of used paperwidths.

In Sudan the result of 15 different corrugator programmes comprising 10 orders each showed that it is possible to reduce the trim waste by 60 - 70%, and the number of total running meters by approx. 10% per programme (by increasing the used paperwidth). The number of used paper widths can be reduced by 40-50%.
In Iraq the result of 53 different orders showed approximately the same result as for Sudan.

FINDINGS AND RECOMMENDATIONS - CORRUGATED BOX PLANTS IN SUDAN

BLUE NILE PACKAGING

FINDINGS

This company is facing severe problems in terms of production facilities, production knowledge and as a consequence of these two main problems, also quality.

Production facilities :

The corrugating machine, which is the main machine in a corrugated box plant, is 25 - 30 years old with a maximum width of 1.6m.
Due to lack of a well organized preventive maintenance system and to some extent lack of spareparts, the corrugating machine (and all other machines) is in poor condition and need a general overhaul in order to be able to run efficiently and produce corrugated board of good quality. The B-Flute single facer should be replaced under all circumstances.

The production area is far too small for the capacity of the machines and furthermore the production area is to a great extent covered with paper scrap and old production machines which are not in production. The roof is leaking during the rainseason, thus complicating storage of finished and semifinished material.

Production knowledge :

There is obviously a lack of production know-how in terms of knowledge of how to operate the machines efficiently Furthermore there is a great lack of basic knowledge in steam, glue and paper technology, which is very important for running different paper qualities and obtaining a good quality.
The production planning is deficient and could be improved thus increasing productivity, and decreasing the waste in the plant.

The consultant spent a great deal of his time to show how to plan the orders on the corrugator. Six different programs were made and a reduction of the trim waste by 60 - 70% was obtained, together with a reduction of the production time (in some cases up to 8 hours in a week) coupled with reduction of used paperwidths.

RECOMMENDATIONS :

In the light of the ovservations made by the consultant during this mission, following recommendations are made :

The recommendations are divided into two groups for this company.

(1) Short term recommendations
(2) Long term recommendations

1°) Short term recommendations

- All the production machines specially the corrugator must undergo a careful overhaul
- The B-Flute Single Facer should be replaced as soon as possible
- It is strongly recommended to start using starch based adhesive instead of present silicate
- The steam system has to be free from present steam-leaks and all the tubes, steam as well as condensate, have to be insulated to reduce energy
- Repair the roof to prevent water to enter during the rainy season
- Clean the production area from paper scrap and no used machinery
- Introduce an efficient reporting-system for the production machines, waste and adhesive consumption (Annex V).

- Introduce a planned Preventive Maintenance System (see Annex I) (It has to be observed that the machines should be overhauled before introducing such a system)
- Introduce a waste control system (see Annex II)
- Start a production planning system (see Annex III)
- Introduce a quality control system
- Change the direction of the "Peters Baby" printer slotter.
- Start training of supervisors and mashine drivers.

2°) Long term recommendations

In order to be capable of competing with other corrugated box plants in the future, following recommendations are proposed :

- Start as soon as possible to make an investment programme for replacing the out of date machinery. Consider purchasing a 2.2 m corrugator.
- Investigate possibilities to extend the production and storage area
- Install a quality control laboratory with necessary testing equipment.

THE PACKAGING HOUSE

Due to the limited time spent with The Packaging House, it was not possible to make a complete assessment of the plant. However, the visit by the consultant, provided enough background to make following comments on the following obvious points.

FINDINGS

The consultant has not seen the corrugator nor any conversion machines in operation. However, The Packaging House possess the widest corrugator in Sudan 2.2m and is operating with 5 paper widths 1700, 1800, 1900, 2000, 2200mm.

In spite of the advantage of being the widest corrugator in Sudan, the corrugator has several defects which make the machine not efficient.
Following defects are observed :

DEFECT	CONSEQUENCE
One Single Facer	Not possible to run Double-wall corr. board
No preheaters	Difficult to run good quality and no means to correct warped board
Single mill roll stands	Each roll change causes corrugator stop
Single cut-off	No combination of orders possible Difficult to make full use of the width - Hight trim waste

The main conversion machines, one printer slotter one folder gluer and three hand stitching machines can not absorb the production from the corrugator, providing that the corrugator run one full shift per day during the working days in a month.
Further more the production area is for to small for one full shift of the corrugator.

The possibility to add a double cut-off, knife which also requires two take off tables, is non existent due to the short distance between the existing single cut-off and the frontwall.

Recommendations

In the light of the observations it is the consultants' strong opinion that the only way to make The Packaging House capable to compete seriousy with the most efficient plant in the area, it is necessary to :

- study possibilities to extend the production area specially in the tength direction of the plant
- if there is no possibility, a complete new lay-out has to be studied
- once the new lay-out has been decided start up grading the corrugator by adding :
  - . Duplex cut-off knife
  - . One Single Facer
  - . Five preheaters
  - . Two preconditioners (for fluting)
  - . Five duplex mill roll stand
  - . Second Glue Unit to the Double Facer
  - . One top-bridge for the new Single Facer
  - . Two take off units.

Depending upon the market situation the need for conversion machines has to be decided.

THE SUDANESE KUWAITI PACKAGING

Due to the limited time, the consultant had no possibility to make an assessment of this plant.
However, following recommendations can be made :

RECOMMENDATIONS

- Start with Planned Preventive Maintenance (Annex I to this report)
- Waste control system (Annex II)

- Production report for :
  - . Corrugator
  - . Conversion machines
  - . Starch consumption

- Planning of the corrugator and the conversion machines could be improved (Annex III)

- Make a total evaluation of the maximum capacity of the plant by establishing a Machine budget and a production flow.

FINDINGS AND RECOMMENDATIONS - CORRUGATED BOX PLANT IN IRAQ

IRAQI COMPANY FOR CARTON MANUFACTURING (ICCM)

Iraqi Company for Carton Manufacturing, is the newest corrugated box plant in Iraq and has been operating for about three years. The company is well organized in all respects, with brand new machinery from the beginning, but not working at full capacity. Taking into accunt that the company has been in operation three years and that the order book is over filled, it should be working at full capacity by now.

There might be many reasons for this, unknown to the consultant. However, the visit by the consultant provided enough background to allow certain comments concerning the efficiency of ICCM.

It must be stressed by the consultant that he was provided with all needed informations to perform his task by the Technical Manager Mr Faris Baher Omar and the Production Manager Mr ISSA Mohammed KADHIM.

FINDINGS

- Buildings, layout of the machines extremely good
- Machinery well maintained
- Work force of good quality and showed great interest in learning about the production technology (specially the supervisor of the corrugator)
- There is a slight lack of basic knowledge in Paper starch and steam-technology
- The machines, in general over manned and not running at full speed
- Raw material (Liner and Fluting) of good quality, even if one lot at fluting from Brazil showed deficient paper characteristics thus affecting the runnability on the corrugator.

RECOMMENDATIONS

In the following, the consultant will give recommendations which merely will "polish" same of the already acceptable operations.

Paper stock

It is strongly advised to store the paper-rolls (liner) in vertical position instead of the presently horisontal. The top roll should be covered with a plastic hood and the bottom roll be placed an wooden planks to avoid humidity, and dirt in form of sand and gravel, to enter the end of the paper roll.

The paper rolls should be stripped from "Loose" paper, which is a big fire risk.

- Reduce the number of paper widths used, to four.

Corrugator

- The amount of starch adhesive applied at the Single Facers should be reduced to a minimum. Will increase the corrugator speed and give better board quality.
- For each Single Facer a bridge over the liner eneterance to the machine should be constructed, allowing the operator to check the Single Face board quality on the drive side and clean the pressureroll from glue build up on the drive side end of the pressure roll during run.
- The step-ladder to the SF-web bridge should be moved close to the Single Facers thus admitting the operator to check the SF-board immediately after a correctin made on the corrugator.
- Under all circumstances, the operator should check the SF-board on the bridge more frequently than presently.

- Cleaning of the Fingers from glue build up should be done with the slot-tool, advised by the consultant to the supervisor. If cleaning of the fingers is made without slot-tool there is a great risk to bend the fingers.

- Always work with a minimum of pressure on the pressere roll against the lower corrugating roll to prevent damaging of liner and fluting

- Steam, used for the Gay-lord and the preconditioner should be of low pressure steam (wet steam).

Double Facer

- The amount of starch adhesive applied to the Single Face board should be reduced to a minimum. Will increase the speed a give better quality of the board.

- When making Double wall board a device should be added to hold the B-Flute web firm when entering the hot plate section of the Double Backer.

- Check the paper speed in relation to the glue roll speed according to the norms given by the consultant.

- Use one piece belt on the Double Facer instant of presently used two-piece belts

- The present belts are moving approximately 10-15mm back and forth cross the machine thus making it difficult to run with minimum 20 mm side trim. Check the crownings on the main belt drum and that the belt tensioning device is working correctly.

- Make use of the advantage with direct cut-off knives, thus running without side trim on the conversion machines.

- The operators of the automatic stackers should inspect the board more frequently

- It is futher advisable to install on the corrugator an automatic stop recorder, which is recording directly on a disc (replaced for each shift) graphs for different kinds of stops (el. steam, paper breaks etc)

- Finally, try to increase the running speed.

Conversion machines

The consultant paid most attention to the corrugator operation, but following recommendations for the conversion machines can however be made :

- Study a conveyer system with transfer car to the different conversion machines
- Lift-tables or automatic feeders should be installed for the conversion machines
- As machine 1 (Gandossi) is out of order, study the possibility to make use of the automatic feeder for this machine for the Saturn II machine, until the Gandossi machine will be in operation
- Pay more attention to the long set-up times and the slow running speeds
- Try to reduce the manning of the machines
- Install appropriat take off tables for the hand stichers (Angel tables) and other minor machines
- Organize the stock of board (waste sheets) used for fittings and get rid of board which will never be used.
- In order to track back claims from customers (Bad printing, unsquare boxes or other quality defects) to the crew responsible, it is advisable to print a code on one of the bottom flaps (inside) showing the date for manufacturing and shift number.

- Stitched boxes should have double stitch at the two corners, specially important for big boxes in Double Wall

- It is advisable to start using "extended glue lap" system on glued boxes (contact the sales-department before introducing this system)

- It is also advisable to install stop recorders, described under "corrugator" on the main conversion machines.

Planned Preventive Maintenance System

Even if the machines are well maintained today, it is advisable to introduce a PPM-System outlined in Annex I.

Planning of the corrugator and the conversion-machines

The Production Manager is presently doing a good job in planning the machines. A special order planning department should be organized for this purpose and recommendations given by the consultant in Annex III could perhaps be of help for this new department.

The result of 53 planned orders in the corrugator showed :

Gross Production	1.653.599	m²
Net Production	1.627.321	m²
Trim Waste	26.278	m²
Total run meters	797.412	m²
Average paper width (gross)	2.07	m
Average paper width (net)	2.04	m
Trim waste %	1.6	%
Used paper widths	4	
Frequency of width	1900 mm = 6%	
" "	2000 mm = 30%	
" "	2100 mm = 4%	
" "	2200 mm = 60%	

Reporting System

It is recommended to start to up-grade existing reporting system (See Reporting-System Annex V).

Quality control

It is recommended to install equipment to perform :

- Ring Crush Test (RCT)
- Edge Crush Test (ECT)
- Pin Adhesion Test (PAT)
- Flat Crush Test (FCT)
- Box Compression Test (BCT)

It is essential for a quality control laboratory to maintain constant climate condition (Ref. Humidity and Temp) It is therefore recommended to install a device to be able to maintain a constant climate according to international standards.

It is further recommended to the quality department to perform manufacturing process control like iodine test of the corrugated board, flute crushing test (Micrometer) (corrugator as well as conversion machines) more frequently.

E - RECOMMENDATIONS

Detailed recommendations for each visited corrugated box plant are given separetely in this report.

In the light of the observations made by the consultant during this mission, the follcwing recommendations are put forward for further in put by UNIDC/ARPAC.

S U D A N

As the corrugated board and box industry in Sudan is in great need of modernization, a consultant in the production of corrugated boxes should spend at least 3 months with the principal Sudanese box makers. During this mission, he would :

1. Advise on necessary investments in order to upgrade existing corrugated box plants emphasizing following :
   - Modern production machines (new or second hand) and in this connection prepare delivery test programmes
   - Efficient plant lay-outs (Propose suitable extensions of existing buildings)
   - Efficient operation of the production machines (In-plant training - Production technology)
   - Basic knowledge in paper - starch-and steam technology.
   - Production planning
   - Quality control

2. Advise on technical specifications, when purchasing raw material (liner and fluting) and inventory (Balance: liner-fluting).

3. Advise on investments in testing equipments in order to up-grade the UNIDO Founded Cellulose Chemistry and Technology Research Unit (CCTRU) to be able to perform corrugated board and box tests.

4. Prepare and carry out a one month study tour to corrugated box plants and one paper mill in Europe for selected people in the plants.

I R A Q

In the consultant's opinion, the overall situation at the ICCM plant is satisfactory but there might be a need for a consultant one or two months to advise on :

1. Production technology
2. Production planning
3. Reporting system
4. Waste reduction
5. Basic knowledge of paper, starch and steam technology
6. Quality control
7. Development of new activities such as manufacturing of Bag-in-Box system, Bliss box etc.

In addition the consultant puts forward the following strong recommendation for the Arab countries participating in ARPAC :

This mission, together with earlier missions in the arab region by the consultant revealed the need for up-grading the production knowledge and training of the production people on all levels in the corrugated board industry, from machine-drivers to the technical managers. To solve this problems, there is a need for a well organized training centre where machine drivers, supervisors and technical managers can be informed and trained in modern production technology. The training programme should comprise theoretical informations and explanations coupled with practical work in a corrugated box plant.

The intention with this centre should also be to train arab engineers to become consultants concerning production technology as well as upgrading of existing plants in the Arab region.

In the light of above mentioned lines of thoughts, the consultant strongly recommend UNIDO/ARPAC to study the possibilities of starting up a training centre.

In the consultant's opinion the Iraqi Company for Carton Manufacturing (ICCM) would be a suitable place to start such a centre for the Arab Region.

In order to prepare the training programme, there is a need for a consultant during 6 months.

ANNEX I

PREVENTIVE MAINTENANCE

In the case of Sudan, parts of the recommendations for the preventive mainteance system presented below have been mentioned in an earlier report from a mission carried out by the consultant on behalf of International Trade Centre (ITC).

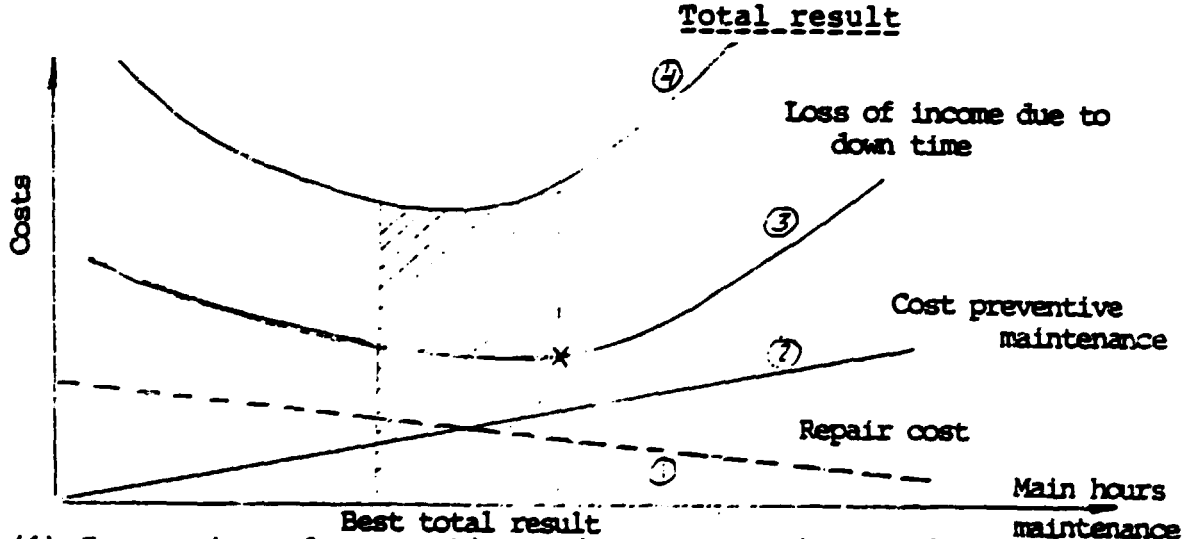
The consultant will here make some comments, giving recommendations to the corrugated board industry in general. A maintenance which must frequently turn to repair work is functioning very badly and maintenance costs will become high. Repaircosts are normally much higher than preventive maintenance costs.

The objective for the maintenance work can be expressed in the following :

TO MAINTAIN THE HIGHEST MAHCINERELIABILITY AT THE LOWEST COST

The economical aspect is very important. It decides how to balance the preventive maintenance against common repair work.

The costs which build up the profitability picture are potted in the following graph



(1) Increasing of preventive maintenance - increasing costs

(2) At the same time decreasing repair costs

(3) The income loss decreases, but only to a certain point (marked x) thereafter the income loss will increase, simply because the preventive maintenance is becoming too expensive and laborious

(4) The total result will thus grow worse if the preventive maintenance is becoming to extencive

Where the curve (4) has its minimum is the optimum for preventive maintenance.
The area marked with lines gives the best result.

The factors that make failure of the production machinery very costly are :

- Lost production time
- Lost man power
- Lost profits
- Lost customer relations (due to difficulties in meeting delivery times).

The primary objectives of preventive maintenance should be :

- To protect the buildings and machinery
- To increase utilization of the machinery thus reducing down time
- To maintain safety
- To control and direct the maintenance labour force
- To economise in the maintenance department
- To maximise utilization of labour and resources
- To prevent waste of tools, spareparts and materials
- To ensure adequate technical information for maintenance
- To obtain cost records for budget

A preventive maintenance programme will not entirely eliminate a machine break-down during a scheduled production-run. However, a well planned programme can prevent many costly and untimely breakdowns. A plan for periodic inspection of specific parts of equipment, to search for unusual wear, or to look for the possible mal function of a moving part will offen

reveal the need for action. By anticipating these problems, one can detect and take action before they become trouble some and serious. A major breakdouwn is more costly and inconvenient to repair than a miner adjustment or the timely replacement of a worn, inexpensive part. Minimizing these problems through planned preventive maintenance can help a lot.

There are several basic requirements for establishing a Preventive Maintenance Programme

- Machine history back records must be available for one or two years
- Workorder request and equipment records should be analyzd to identity causes and frequencies of breakdowns ; this can determine the frequencey if inspections of certain parts and machines
- Check lists, testing procedures, lubricating charts and cleaning methods must be developed
- An analysis of the sparparts inventory must be made so that appropriate parts are on hand as needed
- The need for corrective maintenance must be identified
- An effective and complete work order system must be initiated.

Preventive Maintenance is divided into two types :

a) Machinecrew's responsibility
b) Maintenance Departments'. responsibility

a) <u>Machinercrew</u>

Because of limited time available to them the crew should only be responsible for cleaning and making minor adjustments and checks that can be completed during and between runtimes. The operator of a machine is also responsible for reporting to the maintenance department concerning malfunctiuning of the machine (see Work Order Request).

- The operator is responsible for completion of all assigned maintenance

- Preventive maintenance checklist for each machine are to be used. Each form should be installed in the appropriate block for the days on which each action is completed. Initials should be those of person actually accomplishing the task. By the end of each week the supervisor must verify completicn of all requirements by signing.

- It is also the responsibility of each department supervisor to have each piece of equipment under his control cleaned and in first class condition when it is scheduled for the prevented maintenance check. This will require good communication and cooperation between the departmental supervisors and the maintenance supervisor.

Following form shows a typical work order request to be completed by the departmental supervisor :

WORK ORDER REQUEST
Emergency..... Non Emergency..... Safety..... Regular....
Department: Machine: Requested by: Date.....
Description of work

b) Maintenance Department (Manager)

- Has primary responsibility for accomplishment of the Preventive Maintenance Programme and all follow-up

- Maintain all records needed to support the programme to include historical and cost data

- Schedule preventive maintenance insections and repair work needed

- Co-ordinate with Scheduling and Plant Manager

- Review programme continually for sufficiency

- Process and prioritize work orders

- Inventory and control spareparts

- Continually analyse high cost and repetitive work orders to eliminate cause

A typical weekly preventive maintenance schedule

Machine Number	Description	January					February				March	
		3	10	17	24	31	7	14	21	28	3	10
	Corrugator											
	Single Facer C	X	X	X	X	X	X	X	X	X	X	X
	Single Facer B	X	X	X	X	X	X	X	X	X	X	X
	Double Facer	X	X	X	X	X	X	X	X	X	X	X
	Triplex.sl. Scor.	X	X	X	X	X	X	X	X	X	X	X
	In line mach.I	X	X	X	X	X	X	X	X	X	X	X
	Printer slotter	X	X	X	X	X	X	X	X	X	X	X
	Semi autom. stitch	x	x	x	x	x	x	x	x	x	x	x

Weekly preventive maintenance checklist

CORRUGATOR

Single Facer

1. Check lateral adjustment for freeness
2. Check parallelism of adhesive roll to corrugator roll
3. Check parallelism of doctor roll to adhesive roll
4. Calibrate all clearance indicators
5. Check oil lubricator
6. Check and lubricate all chains and years
7. Check all motors, clean and report any overheating
8. Grease all bearings
9. Clean slots in top corrugating roll
10. Check all heated rolls for proper temperature
11. Check all electrical wiring, controls and switches, make sure all safety locks are working, repair as required
12. Check oil level over riding clutch on adhesive roll drive
13. Check paper speed to adhesive roll speed
14. Check fingers for bent. Replace as necessary

Preheaters and preconditioners

1. Check brakes
2. Check wrap rolls and limit switches

Steam-system Single Facer (daily)

1. Check steam and return lines for leaks. Tag and report leaks that require shutdown for repair scheduling.
2. Check rotating steam joints
3. Check by-passes (closed)
4. Check return pumps for operation.

Steam-system - Single Facer (weekly)

1. Check process steam traps temperatures with pyrometer :

Remarks : _____

Above work done by : _____

Date : _____

Double Facer

1. Check all preconditoners and hotplates for proper temperature
2. Check temperature control for hot-plates
3. Check preheater : brakes, wraprolls and limit switches
4. Check adhesive, doctor roll for parallelism
5. Check scraperblade doctor roll for clean wiping
6. Check all motors, clean and report any over heating
7. Check main belts for proper tension, worn edges and torn laces repair as necessary
8. Check all electrical wiring

Remarks : _____

Above work done by : _____

Date : _____

Triplex slitter scorer

1. Check shatts for dents, mistreatment and sand if necessary
2. Check slitting and scoring heads and bolts for worn threads and worn sockel heads
3. Check lateral adjustment
4. Check drinve years for wear, lubricate
5. Check chains and sprockets
6. Check circular knives for wear replace as necessary

Cut - off

1. Check over speed pull roll for cleanliness and proper adjustment
2. Check reservoirs for proper oil supply
3. Check Reeves drives (if not direct drive)
4. Clean and check cut-off length adjusting brake motor

Remarks : _____

Above work done by : _____

Date : _____

Above mentioned maintenance schedule and checklists are exemples of how to perform preventive maintenance.
There are a number of other points to be checked depending upon machine manufacturer (Langston, Peters, Martin, BMF etc...)
In the case of the Langston Corrugator at ICCM Iraq, the operating manual for the corrugator contains several points to be checked and it is recommended to include those points into the checklists.
The Maintenance Manager has to decide what to be checked weekly, monthly or any other decided period.
Similar checklists should be established for all production machines.

ANNEX II

WASTE CONTROL

The waste control in a corrugated plant is one of the most important measures to take in order to reduc the costs. It could mean the difference between profit and loss. Assume a production of 10000 tons of corrugated board per year.
Price per ton 500 US$
Paper cost per year 5 000 000 US$
One percent means 50000 US$
"Added value" in terms of handling and conversion has to be added and depends upon the conversion degree of the operation.
There are many reasons for waste,and they could be split up into three main categories.

- Paper transport waste (from the supplier to the boxplants)
- Paid waste
- Avoidable waste

Paper transport waste

To some extent paid by the insurance company

Paid waste

Box design waste and have to be paid by the client.

Avoidable waste

This is the type of waste, which can be reduced by careful planning and manufacturing in the boxplant.

Following actions have to be taken to reduce the waste in a corrugating plant.

(1) Define the sources of waste
(2) Analyse the sources
(3) Implementation of a waste control system.

(1) SOURCES OF WASTE

In order to get a clear picture of how and for which reasons the waste is generated in different areas, it is necessary to start a systematic investigation emphasizing the following points :

a) Raw Material

- External transport damages
- Internal transport damages
- Moisture damages in the paper stock
- Supplier's waste

b) Corrugator

- Rollpeel
- Bridge waste
- Splice waste
- Quality change
- Width change
- Corrugator stops
- Core waste (core + paper)
- Edge trim
- Cut-off error
- Edge misalignment
- Bonding (liner to fluting)
- Warped sheets

c) Material in process

- Transport damages
- Stock damages
- Broken pallets

d) Slotters, in-line machines, stitching machines, Die-Cutting machines

- Start-up sheets
- Edge trim
- Feeding errors
- Manufacturers point errors

- Unacceptable printing
- Slotting error
- Creasing error
- Printing out of register
- Slot waste
- Ink stains
- Warped sheets
- Automatic stacker waste

e) Others

- Claims

Above mentioned sources of waste are of course applicable in any box plant, but are more or less important due to the ordermix, average order length, type of machinery, lay-out and type of transport handling system.

(2) ANALYSE THE SOURCES

a) Raw material

- External transport damages

This means the transport from the paper mill to the place of discharge at the corrugating plant. From the time the local clamp truck grabs the roll it is, internal transport and thus the plant is responsible for any damage of the roll.

It is important that every delivery is checked in respect to damages (before unloading) in order to find out, in which condition the rolls arrive from a specific supplier If it has been established that are (or several) suppliers have more damages than the others, it must be announced to the supplier. For every delivery should be recorded

- Type of damage
- Weight of the waste
- Supplier
- Order number and roll number

In most cases, the paper suppliers appreciate this in formations. With a good cooperation between the supplier and the corr. plant the external damages can be considerable reduced a part from transport damages, the roll should be inspected (if necessary recorded) with regard to the following points upon arrival

- Even roll ends
- Quality
- Moisture damages
- Bands (edge)
- Cores
- Clean marking (roll number, order number etc)
- Roll width
- Winding (loose or uneven)

- Internal transport damage

Almost 100 % of the internal transport damages are due to careless handling by the clamp truck driver when unloading and transporting the roll.

If the aisles in the paper stock are too narrow or the rolls are placed too close to each other, there is a risk of damaging other rolls with the truck.
To reduce the internal damages following points have to be observed :

- Never let a roll drop from a loring, if necessary use tyres
- Never drag a roll over the edge of the lorry's platform
- Have the pinches sufficiently open when grabbing the roll
- Do not squeeze the roll to much
- Transport the roll with sufficient distance between the roll end and the ground (when vertically transport)
- Place the roll with care
- Paper qualities used with high frequency should be stored closer to the corrugator than other qualities
- To avoid moisture damages from the floor or gravel to enter the roll end, the rolls should be stored an wood plants
- Inform the truck driver about the value of the paper

A part from the waste, it has to be mentioned that loose paper on the rolls in a paper stock is RISK OF EXTENDED FIRE if a fire starts in the plant.

- Moisture damages

For indoor stock the roof has to be in good condition to prevent water to enter when rainings

- Inspect the roof frequently.

For outdoor stock, the end of the top roll (vertically stacked) should be covered with a hood of plastic or similar material.

- Suppliers waste

This type of waste occurs when there are defects in the roll which origins from the manufacturing of the paper roll, such as bad splices, wrinkels in the paper, stains in the paper etc

This type of defects must be announced to the supplier and also recorded by the corrugator operator or the man in charge of the waste control.

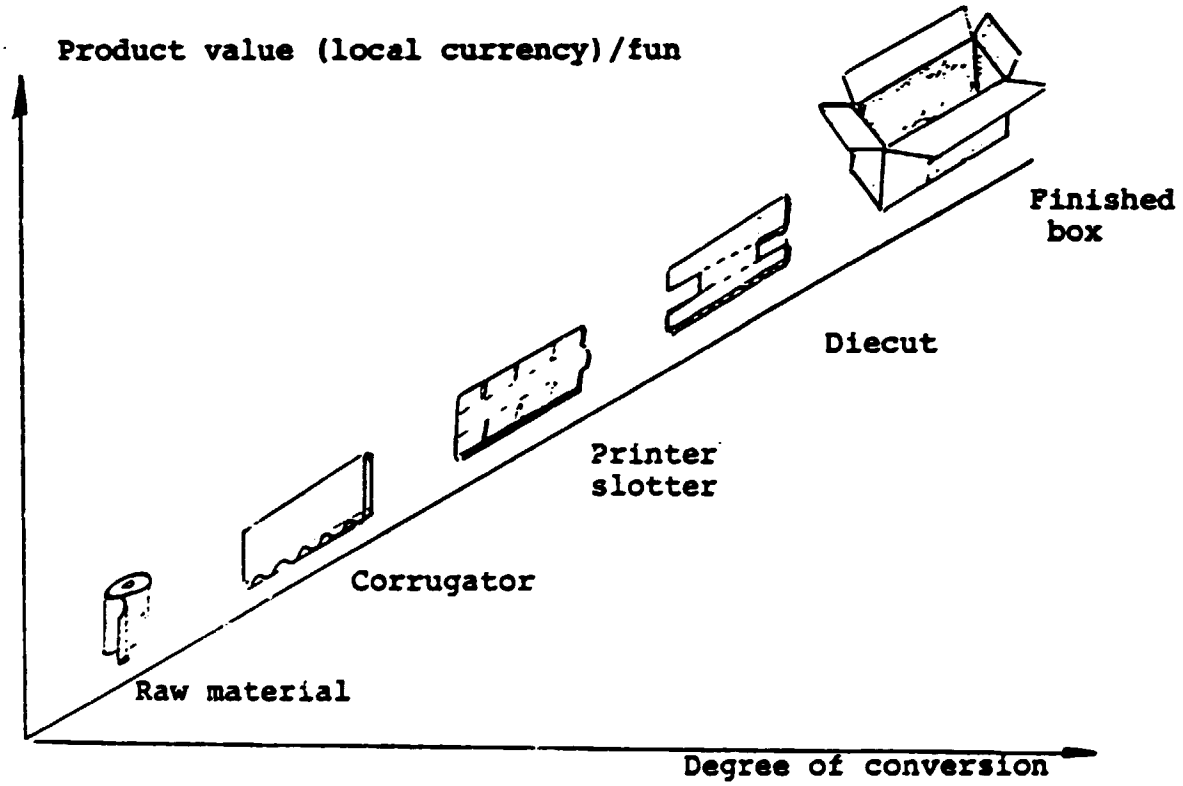
WASTE CONTROL SYSTEM

It must be pointed out that anay waste reduction system must be carefully studied before put into operation, which means that for a period of time (2 - 3 weeks) a study must be carried out in order to determine where, when and how the waste is generated.

It must also be understood by the management, that one person should be responsible and only occupied with this very important matter for approx half a year. The person in charge must be competent in all phases of manufacturing of corrugated board and boxes.

THE SYSTEM MUST BE STRONGLY SUPPORTED BY THE MANAGEMENT

Before starting up a waste reduction system, it is of utmost importance that everybody in the plant is informed about the objective of this study. Everybody should be informed about the value of paper, board in process and the finished box according to the following figure, which could be posted in the plant.



Following categories of waste should be recorded in table form

Core waste Met

Weight of cores without paper

Waste not baled

Could be all sheets incl. claims

Waste baled

Obvious

Die-cut Waste (Box design waste)

This type of waste do not include bad sheets only trim waste obtained by weighing one sheet before and after processing. The difference multiplied by the number of delivered sheets, will give the total trim waste. It has to be observed that 10 sheets should be taken randamly, not consecutive.

Slot and Manufacturers Joint Waste

See above.

Corrugator Waste

Transport damage

External transport waste

Damages in plant - Bridge drop waste

- Stripped waste from roll
- Bridge drop waste
- Missed splice waste
- Waste due to paper break

Core Waste

Paper left on cores when splicing

Sheet Waste

Reject at take-off end

Trim Waste

Obtained from the planning department or by measuring the trim for each order combination and weighing 1m of total trim multiplied by the total running-meters of a certain order combination will give the total trim waste.

Claims (reject) from cutomers

Sorted out in conversion. Should be considered as "SHEET WASTE" Corrugator.

Other conversion waste

- Start up sheets conversion machines
- Rejected sheets at the conversion machines (feed end) could be warped sheets to be recorded under SHEET WASTE Corrugator
- Jam-ups
- Rejected sheets at take-off end conversion machines
- Internal transport damages.

Carts or boxes should be organized for each type of waste to be recorded. It is further recommended to paint carts or boxes and print number, type of waste and the weight of the carts or boxes on the side.
It is also recommended to paint carts for the corrugator, for example Green and carts for the conversion, machines Brown.

Weight Waste Report

Following form should be available at the scale and filled out by the person in charge of waste control

WEIGHED WASTE REPORT

Date .....

CART.NUMBER	GROSS. WT.	TARE WT	NET WT

Shift (circle one) 1. 2. 3.

CORRUGATOR	X	
Core Weight net Stripping waste roll Bridge drop Missed splice Paper break Core Weight (paper) Rejects take off		
CONVERSION	X	MACHINE :
Start up sheets Rejected sheets (feed) Jam ups Rejected sheets (take-off) Internal transport		
OTHER SOURCE (Describe)		

ACCOUNTABLE WASTE REPORT

Following forms are to be filled out by the person in charge of waste control.
The forms breaks down the waste into the same major categories as the weight waste report. The forms are sorted by categories and a total weight is established by adding the net weight.

ACCOUNTABLE WASTE

Shift (circle one) 1. 2. 3.

Machine : Corrugator Date .....

S O U R C E	W E I G H T
Core weight net	----------
Stripping weight roll	----------
Bridge drop	----------
Missed splice	----------
Paper break	----------
Core weight (paper)	----------
Rejects take off	----------
TOTAL	==========

ACCOUNTABLE WASTE

Shift (circle one) 1. 2. 3.

Machine : ..... Date .....

S O U R C E	W E I G H T
Start up sheets	----------
Rejected sheets (feed end)	----------
Jam - ups	----------
Rejected sheets (take off)	----------
Internal transport	----------
TOTAL	==========

MONTLY PRODUCTION REPORT : PAPER WASTE

N°	Item	January		February		Year to Date		March		Year to Date		April		Year to
		Ton	%	Ton	%	Ton	%	Ton	%	Ton	%	Ton	%	Ton
1	Paper consumption													
2	Dry starch + Borax + Caust Soda													
3	Total board (1) + (2)													
	Corrugator Waste													
4	Core weight net													
5	Stipping weight (roll)													
6	Bridge drop													
7	Missed splice													
8	Paper break													
9	Core weight (paper)													
10	Rejects (take off)													
	Total Waste Corrugator													
	Conversion Waste (4)to(10)													
11	Start up sheets													
12	Rejected sheets (feed end)													
13	Jam ups													
14	Rejected sheets (take off)													
15	Internal transport													
	Total Waste Conversion (11)to(15)													

Trim waste from the corrugator and the conversion machines should be presented separately in a similar way.

The percentage figures for columns (4) to (15) are calculated on the weight of total board (column (3))

Year to Date columns are accumulated figures in order to present the actual situation for each type of waste.

FURTHER SUGGESTIONS

- In order to encourage the plant to take actions against the waste problem it could be advisable to let the production people benefit from the saving.

- Graphs showing the result should be placed in the plant.

ANNEX III

PLANNING CORRUGATOR AND CONVERSION MACHINES

CORRUGATOR SCHEDULING

With a proper scheduling of the corrugator, it is possible to reduce the trim waste, reduce the number of paper widths used (reduction in paper change waste) and increase the capacity (m^2/h) of the corrugator. The scheduling should be carried out in such a way that all delivery dates are met in the most cost-effective way.

Following points should be observed by the scheduler :

- Minimize side trim
- Try always to run on maximum paperwidth
- Minimize of set - ups
- Maximize out put
- No down grading or upgrading without sales departments' or managements' approval
- Decide which shift should run new or special orders
- No overtime without Production Managers approval
- The sales department should be informed immediately if some machine breaks down, causing change in delivery time
- The scheduler should inform the sales department in "difficult to trim" situations and give information about extra costs in such a situation
- Scheduler and sales department should decide over or under-runs (Normal praxis ± 5 %)
- Scheduler should approve changes in programmes.

The scheduler should record and be aware of the following constraints, limitations and influences.

(a)
- The backlog in front of each machine
- Roll widths of each grade / weight combination available and the inventory of each
- Be aware of old roll stock which should be eliminated from inventory through consumption

- Cut-off knife limitations
- Slitter - Scorer limitations
- Average corrugator speed for different qualities
- Availability of special materials such as wax, tear tape and so on
- Maximum over or under run acceptable on an order
- Minimum run lengths
- Minimum side trim
- Floor space availibility

(b) Sort orders into groups according to common flute, and quality.

(c) Arrange orders within each group in sequence by date required off corrugator.

(d) Within a given group, combine the orders considering following principles

- Cross trim first, self trim last
- Minimize the "number out" on orders with small lineal meters
- If there are several short runs, arrange them to allow the slitter man to make set-ups for a slitter scorer off the corrugator.

When the number of required orders exceeds the corrugator capacity, the scheduler should consult the sales department to find out which of the orders should take priority.
If the number of required orders do not absorb the capacity of the corrugator or are difficult to combine the scheduler should consider other orders (in cooperation with the sales department) which do not have to be run immediately but will aid in the minimizing of the trim, maximization of width and speed or balancing of conversion machines.

(e) If possible, sequence the cutting lists (programmes) so that conversion machines are not idle and so that

- All of one flute type run together
- Widths run wide to narrow
- Grades run heavy to light

PLANNING OF CORRUGATOR (Example)

Following 10 orders, randomly chosen, from the list of "out standing orders" for Nov 1986 at ICCM Iraq may serve as example of how to make up a programme for the corrugator.

Following assumptions are made :

- Max width of the corrugator
- Min total side trim 25mm
- Paper widths used presently at ICCM
  - 1850 mm
  - 1900 "
  - 1950 "
  - 2000 "
  - 2050 "
  - 2100 "
  - 2150 "
  - 2200 "
- One order may be repeated max 4 times in differnet combinations
- The actual order numbers have been replaced by 1. 2. 3.....10 in order to facilitate this example
- One to two mm can be cut from sheetwidth on big boxes in order to obtain 25mm side trim for a combination. It should be observed that the corrugator at ICCM should be able to run with min 20mm side trim

N°	QUANTITY SHEETS (boxes)	Sheet Length mm	Sheet width mm	Width x 2 mm	W x 3 mm	W x 4 m	W x 5 mm	Run meter Single Sheet m	Net : Production m²
1	107.000	820	985	1970				87.740	86.424
2	5.000	1660	812	1624				8.300	6.740
3	20.000	2000	752	1504				40.000	30.080
4	25.000	990	552	1104	1656			24.750	13.662
5	25.000	1050	537	1074	1611	2148		26.250	14.096
6	100.000	1260	530	1060	1590	2120		126.000	66.528
7	20.000	1160	492	984	1476	1968		23.200	11.414
8	40.000	1110	472	944	1416	1888		44.400	20.957
9	30.000	976	417	834	1251	1668	2085	29.280	12.210
10	50.000	1120	392	784	1176	1568	1960	56.000	21.952
Tot.	422.000								

Total : 284.063 m²

Observe that the orders have been arranged in falling widths.

PLANNING CHART CORRUGATOR

ICCM Date 17.10.86

ORDER	N° BOXES	DIMENSION W(mm)	DIMENSION L (mm)	Run meter	OUT	UP Cut - off	LOW Cut -Off	RESTRUN m	RESTRUN boxes	N° BOXES ± 5%	TOTAL Widht mm	ROLL width mm	DIFF mm	WASTE m²
3	20000	752	2000	40000	2	20000				20000				
8	40000	472	1110	44400	1		44400	24400	21982	18018	1976	2000	24	480
8	21982	472	1110	24400	3		8133			21982				
4	25000	552	990	24750	1	24750		16617	16785	8215	1968	2000	32	260
4	16785	552	990	16617	1	16617		12467	12593	4192	2176	2200	24	100
2	5000	812	1660	8300	2		4150			5000				
4	12593	552	990	12467	1	12467		3717	3755	8838	2163	2200	37	324
5	25000	337	1050	26250	3		8750			25000				
4	3755	552	990	3717	1	3717				3755				
6	100000	530	1260	126000	3		42000	38283	91150	8850	2142	2200	58	216
6	91150	530	1260	114849	3		38283			91150				
10	50000	392	1120	56000	1	56000		17717	15819	34181	1976	2000	24	919
10	15819	392	1120	17717	3	5906				15819				
1	10700	985	820	87740	1		87740	81834	99798	7202	2161	2200	39	230
9	30000	417	976	29280	4	7320				30000				
7	20000	492	1160	23200	1		23200	15880	13690	6310	2160	2200	40	293

ICCM Date : 17.10.86

PLANNING CHART CORRUGATOR (continuation)

N° BOXES	DIMENSION W(mm)	DIMENSION L (mm)	Run meter	OUT	UP Cut - off	LOW Cut -Off	RESTRUN m	RESTRUN boxes	N° BOXES ± 5%	TOTAL Widht mm	ROLL width mm	DIFF mm	WASTE m²
13690	492	1160	15880	2		7940			13690				
99798	985	820	81834	1	81834		73894	90115	9683	1969	2000	31	246
90115	985	820	73894	2					90115	1970	2000	30	1108
								Total	422000			Total	4176

Result of the planning :

Gross production	288.239 m^2
Net production	284.063 m^2
Run meters, total	141.146 m
Trim waste	4.176 m^2
Trim waste %	1.4 %
Paper width gross	2.04 m
Paper width net	2.01 m
Number rollwidths	2

2000 mm roll width 50 %
2200 mm roll width 50 %

It is recommended to study the possibility to reduce the number of paper widths at ICCM to 4 (1900, 2000, 2100, 2200)

The procedure of how to combine the orders has been explained in detail to the plant managers at the corrugated plants visited during the mission.

CONVERSION MACHINES SCHEDULING

(a) Machine Backlog System
(b) General rules for planning of conversion machines

(a) Machine Backlog System

A machine backlog system is may be the most essential part of sales and production planning functions of a box plant; It is the system which :

- Allows the sales department to accept orders for a certain requested delivery date, with the knowledge that the plant can meet that schedule

- Gives the production department an estimate of the near-term demand requirements (e.g. how many shifts, how much overtime) on each machine

- Guides the sales department in the type and amount of short-term demand (orders) it should accept or in some cases avoid.

A proper operation of the backlog system requires communication between sales department and production planning.

The key principle behind a backlog system is that the plant can decide approximately when a certain order will be run on a given machine, based on :

- Requested delivery date
- The sequence of machines that a certain order must go through

Although corrugator scheduling and conversion machine scheduling are still required for the daily detail, the two informations are sufficient to analyse the short-term demands on production machinery.

The technique is simple, start with the requested delivery date and back up one working day for each machine the order must pass through.

Example :

Requested delivery date	Tuesday	Nov. 86
"Expected" shipping date	Monday	Nov. 86
"Expected" flexo date	Sunday	Nov. 86
Expected corrugator date	Saturday	Nov. 86

Once the order is broken down into the days it is expected to be processed at each machine, it can be combined with other orders to show the total m^2 demand on each machine each day.

The next part in the process is a comparison of this demand by machine with the machie capacity.
As long as demand is lower than capacity, the backlog system merely tracks the short-term situation. As demand approaches or exceeds capacity, different alternatives exists :

- If there is excess capacity in the days immediately before or after the day in question, no action is required. Since the exact scheduling of an order will not always be the same as the "approximate" schedule in the machine back log system, the one day shortages of capacity are "fixed" by running some orders slightly ahead of or behind the backlog plan.

- If the capacity is fully booked for several days, the production manager can consider overtime for the machine(s) in question for a limited period of time.

- If overtime is not available as an option, sales department can continue to accept orders in excess of capacity, provided that the delivery date on other orders can be changed

- In some cases excess demand can be handled by diverting some orders to other machines.

A weekly machine backlog is shown on the next page. The scheduler should have tables for at least one month, and be filled in at the end of each day.

A copy of the backlog should be distributed to the sales department and production manager every day and to the General Manager every week. For more detailed backlog there could be established Daily Order Log.

WEEKLY MACHINE BACKLOG (Example)

MACHINE	Current Operating Posture Mm²	CAPACITY		Saturday		Sunday		Monday		Tuesday		Wednesday		Thursday		Week N°	
		Mm²/day	Mm²/week	Mm²	%	Mm²	%	Mm²	%	Mm²	%	Mm²	%	Mm²	%	Mm²	%
Corrugator	22	48.8	244	60	122	55	113	49	100	43	88	42	86	36	74	307	126
Inline machine																	
Printer slotter																	
Die cut mach																	
Stitching																	
Bundler																	

General rules for planning of conversion machines

Objective :

Develop a schedule for running orders on conversion machine, which maximize utilization of available labor and machines to meet custumer and production need.

Policy :

- No late order without approval from sales department
- No overtime without approval from production manager (non-scheduled overtime can be authorized by supervisor in emergency or cost saving situation)
- No idling of machines, except when the result is savings in manufacturing costs
- The scheduler must approve any changes in set-up schedules
- Each department supervisor must review schedules to make sure they can be run (e.g. available supplier within machine capability)
- Discovery of an over-run or an order-run should be reported to sales department for instructions
- Schedules, which conflict with normal practices should be reported to production manager for solution
- Keep necessary personnel informed about order backlog by machine and crew availability so that order booking can be handled more efficiently.

Procedures

Record and be aware of the following constraints, limitations and influences :

- Machine capacities (Mm^2/hour and set-up time)

- Machine limitations
    - . Width
    - . Length
    - . Number out
- Machine availability (interruptions due to maintenance, crew absence etc)
- Availability of ink, printing or cutting dies, pallets etc
- When possible, try to achieve following efficiences :

Minimize set-up time by :

- . Running all of one colour job together
- . Running light colours to dark colours
- . Running identical or nearly similar sizes together
- . Running wide to narrow.

ANNEX. IV

PRODUCTION FLOW IN A CORRUGATED BOX PLANT

The production flow in a corrugated box plant shows the utilization of the production machines for a certain sales volume.

The sales volume is estimated by Management, Sales Department and to a certain extent the Production Managment, for a period of one year. However, in order to determine the production flow, the production manager must predict the capacity of the production machines based upon a reliable production report system.

In the following, the consultant will show how to calculate the production flow for ICCM - Iraq, based upon a total sales volume of 22 million square meters (22 Mm^2) for the year 1987.

The figure 22 Mm^2 has been obtained from the Management The distribution between Regular Slotted Container (RSC) and Die-Cutted in terms of Mm^2 is a very approximative estimation done by the consultant. The management can of course make this estimation more precise. Also the capacity figures for the machines have been estimated by the consultant, based upon experience from similar machines (Average production figures). In the case of ICCM, the figures may be reduced for the comming year. However, the following may serve as an example and estimated figures can be changed according to the present situation.

Table 1 : shows a realistic development of the sales volume for the comming 5 years.
The change in out-put between RSC and Die-Cutted boxes reflects the trend in the world.

Table 2 : shows the capacity figures in m^2/hour and Mm^2/shift year (columns 7 and 8), columns 1 - 6 are based upon production reports.

Table 3 : shows the production flow and is self-explaining. Waste % figures are based upon experience from similar machines (More precise figures could be obtained from the waste study proposed by the consultant).

Table 4 : shows the degree of utilization for each machine and is obtained by dividing the actual out put by the capacity figures Mm^2/shift year.

Table 1

I C C M SALES BUDGET 1987 - 1991

YEAR	SALES Mm²	SALES TONS	R S C				DIE CUT						OTHER	
			GLUED		STITCH		SHEET		GLUED		STITCH		PARTITION	
			Mm²	%	Mm²	%	Mm²	%	Mm²	%	Mm²	%	Mm²	%
1987	22.000	13.000	17.600	80	3.300	15	1.100	5						
1988	24.000	14.400	18.000	75	4.800	20	1.200	5						
1989	29.000	17.400	20.300	70	5.800	20	2.900	10						
1990	35.000	21.000	22.750	20	7.000	20	5.250	15						
1991	45.000	27.000	24.750	55	9.000	20	11.250	25						

Table 2

MACHINE PERFORMANCE

WORKING HOOR PER YEAR

MACHINE	SET - UP TIME	OP. SPEED	IND TIME	CREW	AVERAGE ORDER SIZE	AVERAGE BOX PAPER	CAPACITY	CAPACITY
	Hours	Box/Hour	%		Boxes	m^2	m^2/Hour	Mm^2/SHIFT YEAR
	1	2	3	4	5	6	7	8
CORRUGATOR		6.600	15	8		2.05	11.500	26.956
GANDOSSI	0.25	2.000	15	5	20.000	3.0	4.975	11.661
SATURN II	0.25	6.000	15	5	50.000	0.85	4.211	9.870
UNIVERSAL	0.75	5.000	15	5	40.000	1.0	3.886	9.109
PETERS ROTARY	1.0	2.500	10	4	20.000	1.2	2.400	5.626
UNIVERSAL JUMBO	0.5	500	10	4	13.000	4.0	1.766	4.140
PLATEN GAMDOSSI	0.5	1.200	5	2	15.000	1.1	1.206	2.827
SEMI AUTOM STITCH	0.15	500/MACH	5/MACH	2/MACH	13.000	0.9	845	1.981
HANDSTITCH	-	350/MACH	5	2	13.000	0.6	398	933

$$\text{Capacity } m^2/h = \text{Col. 5} : \left(\frac{\text{col 5}}{\text{col 2}} + \text{Col 1} \right) \times \left(1 - \frac{\text{col 3}}{100} \right) \times \text{col 6}$$

Working hours per year/shift = 2344

Table 3

I C C M PRODUCTION FLOW : FOR SALES : 22000 Mm² 1987

M A C H I N E	TOTAL Mm²	W A S T E		GANDOSSI	SATURNY	UNIVERSAL	ROTARY	JUMBO	PLATEN	SEM. STITCH	HAND STITCH	SHIPPIN
		%	Mm²									
BOARD CONSUMPT.	24.229	3.5	848									
CORRUGATOR	23.381	3	701	2784	10304	7835	928	622	202			
GANDOSSI	2.784	3	84									2.70
SATURNY II	10.309	3	309									10.00
UNIVERSAL	7.835	3	235									7.60
ROTARY DIE	928	3	28									90
J U M B O	622	3	22							404	201	
PLATEN	202	1	4									20
SEM. STITCH	404	1	4									40
HANDSTITCH	201	0.5	1									20
T O T A L		9.2	2.236									22.00

DEGREE OF UTILIZATION

M A C H I N E	Out put Mm²/year	Capacity Mm²/ year	Degree of utiliza-tion (shift)	Total Hours/ Year
Corrugator	23.381	26.956	0.87	2.033
Gundossi	2.784	11.661	0.24	560
Saturn II	10.309	9.870	1.04	2.449
Universal	7.835	9.109	0.86	2.016
Rotary die	928	5.626	0.16	387
Jumbo	622	4.140	0.15	352
Platen	202	2.827	0.07	167
Sem.stitch	404	1.981	0.2	478
Hand stitch	201	933	0.22	505

The number of total hours can be split up in set-up hours, indirect hours, Run hours according to following formulas :

$$\text{Number of orders} = \frac{\text{Mm}^2 \times 1000}{\text{Avg blank size} \times \text{Avg.order size}}$$

$$\text{Set-up hours} = \text{Number of orders} \times \text{set-up per order}$$

$$\text{Run hours} = \frac{\text{Mm}^2 \times 1000}{\text{Number per run hour} \times \text{Avg blank size}}$$

$$\text{Tot. Machine hours} = \frac{\text{Set-up hours} + \text{Run hours}}{1 - \frac{\text{Ind time \%}}{100}}$$

$$\text{Ind. Mach hours} = \frac{\text{Ind time \%}}{100} \times \text{Tot. Machine hours}$$

Example : Saturn II

Number of orders = $\frac{10.309 \times 1.000}{0.85 \times 50.000}$ = 242,6

Set-up hours = 242.6 x 0.25 = 60.65

Run hours = $\frac{10.309 \times 1.000}{6.000 \times 0.85}$ = 2021.3

Tot. Mach hours = $\frac{60.65 + 2021.3}{1 - 0.15}$ = 2449 (see table 4)

Ind Mach hours = 0.15 x 2449 = 367.4

Ind Mach hours Set-up hours + Run hours = 2449 (see table 4)

ANNEX V

REPORTING SYSTEM

A good reporting system is essential for the management in order to predict the future fo the company with statistics based upon different reports from sales department and production department, the management can get an idea about the activities fo the company and predict the future for sales activities and production activities.

Machine performance
Production flow
Machine budget
Paper consumption
Manufacturing budget
Volume of necessary investments etc

In other words REPORTING SYSTEM IS THE MOST IMPORTANT TOOL WHEN MAKING THE YEARLY BUDGET.
Finally it must be stressed that all figures collected and recorded must have a meaning to somebody in the organization. Collecting and recording data just for the sake of recording, has no meaning if they are not used in a proper way, which mean that the RECORDINGS should contribute to the company's "GOOD HEALTH"

In the Annex II are shown some examples for :

. Production report corrugator
. Starch consumption report
. Waste report

By experience, it has been convinient to record all months on one single page, with accumulated figures after each month as outlined below :

Item	Jan	Febr	Accum. Year to Date	March	Accum. Year to Date	April
Production Mm^2 Working hours etc	2800	3700	6500	3432	9932	3599

Each month a copy is sent to the management, which thus can follow the production for the actual machine, without looking into several reports for comparison month to month.
Each individual plant may have need for other informations than outlined by the consultant. They may be added

Monthly Production Report : Corrugator

1. Mm^2 produced (Gross)
2. Mm produced
3. Tons paper consumption
4. Crew members
5. Machine hours
6. Man hours (4) · (5)
7. Man hours per Mm^2
8. Production C-Flute
9. % C. Flute of total (8) · 100 : (1)
10. Production B-Flute
11. % B-Flute of total (10) · 100 : (1)
12. Production C/B
13. % C/B of total (12) · 100 : (1)
14. Mm^2 per machine hours
15. % Utilization of 3 shifts
16. Down time hours
17. % Down time of total machine hours (16) 100 : (5)
18. Gross Machine speed m/min stops included (2) : 60 x (5)

19. Net Machine speed m/min (actual working hours) (2) : 60 (15-16)
20. Avg. Board grammage/m² (3) x M x 1000) : (1)
21. % Avg side trim (from planning department)
22. % Dry starch consumption gr/m² (See special report)
23. Avg. paper width (gross) m (1) : (2)
24. % utilization of full width (23)·100 : (Corr. width)

Monthly Prod Report : Conversion machines

1. Mm² converted
2. Number of sheets processed
3. Crew members
4. Set-up hours
5. Run hours
6. Machine hours (4) (5)
7. Stop-hours
8. Indirect hours (cleaning)
9. Total hours (4) + (5) + (7) + (8)
10. % Set-up hours en total (4) x 100 : (9)
11. % Run hours on total (5) x 100 : (9)
12. Man hours Set-up *(Number of workers) x (4) during set-up
13. Man hours Run **(Number of workers) x (5) during run

* May be the whole crew not necessary for set-up Workers not present, sent for other job during set-up time (should be recorded)

** Heavy or complicated boxes may need more workers temporary (should be recorded)

14. Man hours per Mm² (12) + (13) : (1)
15. Number sheets fed per Total hours (2) : (9)
16. Number sheets fer per Machine hour (2) : (6)
17. Number of set-ups
18. Set-up minutes per set-up (4) x 60 : (17)

19. **Number of printed boxes**
22. **% Number printed boxes of total** (19) x 100 : 2
23. **Number of unprinted boxes** (2) - (19)
24. **% Number unprinted boxes of total** (23) x 100 : 2

Monthly Starch Consumption Report

1.	Consumption dry starch	Kg
2.	Consumption Borax	Kg
3.	Cànsumption Caustic Soda	Kg
4.	Total dry adhesive	Kg (1) + (2) + (3)
5.	Production corrugator total	Mm^2
6.	Avg. glue consumption corrugator	gr/m^2 (3) : (5)
7.	Production C-Flute	Mm^2
8.	% C-flute of total production	%
9.	Production B-Flute	Mm^2
10.	% B-Flute of total production	%
11.	B-Flute equivalent to C-Flute	Mm^2 (9) x flute ratio
12.	Production C/B-Flute	Mm^2
13.	% C/B-Flute of total production	%
14.	C/B equivalent to C-Flute	Mm^2 (12)x(flute ration + 1)
15.	Total production corrugator expressed in C-Flute	Mm^2 (7)+(11)+(14)
16.	Dry starch consumption (expressed in C-Flute)	gr/m^2 (4) : (15)

$$\text{Flute ratio} = \frac{\text{Number B-Flute per meter}}{\text{Number C-Flutes per meter}}$$

$Mm^2 = 1000\ m^2$

Monthly Waste Report

See Annex Waste Control System