Production Chart Technique for Profit Optimisation

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In a paper producing unit, setting up the proper manufacturing programme is of utmost importance. Any improper setting not only reduces the profits by Millions of Rupees, but may also create unexpected problems.

In this paper, systematic approach of drawing the production pattern has been explained with example. Various factors like certain plant limitations and sales restrictions worth considering and the method of taking those factors into account are also explained.

Particularly, it is emphasised that the pattern must be based on the optimum utilisation of the key factor of a unit rather than overall volume of production and that is how the profits can be optimised. In this paper, the pulp supply has been assumed as the limitation factor and by following the systematic approach, it is shown how the profitability can be improved by over a Million Rupees.

INTRODUCTION

Though there is no common pattern of production for all paper mills, the one way to fix is to make a 'model' compiled after taking into account different limitations and restrictions of one's own unit. The exercise may be checked periodically with the experiences of competitive concerns of the industry as a whole. The exercise has also to be made within the constraints imposed by the Government authorities, moral duty, customer satisfaction etc. The ultimate object of framing a 'model' is to optimise the profits of the concern after taking into account all such limitations and restrictions.

The overall profitability of a paper mill depends mainly on its pattern of production which will have to be drawn periodically, whether it is for the year, month or for day-to-day production planning. And, in this paper, the technique of selecting the best pattern of production has been explained with example, particularly when there are certain limiting factors. The technique of using different methods of Chart has been suggested, which is very simple to calculate and construct. This Chart device will prove to be very helpful tool for production planning and are flexible in nature to incorporate any change to suit the requirements of one's own unit. In short, once prepared, they will serve as Ready Reckoner, till further major change in its components is required.

For the purpose of framing the pattern, it is essential to study the cost structure of its products. Then a Chart will have to be prepared summarising the profit for each of the products. Finally, the pattern will have to be selected in a systematic manner taking into account all the limitations and restrictions of a unit. This technique will not only optimise the profits of a unit but avoid eleventh hour complications.

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COST STRUCTURE AND ITS IMPORTANCE IN PRODUCTION PLANNING

The entire cost structure of any product can be divided into variable and fixed costs. Variable cost stands for that part of the total cost which varies in proportion to the volume of production, e.g. cost of raw material, chemicals, dyes etc., whereas fixed costs theoretically remains same irrespective of production volume within a particular range.

This aspect is being further discussed considering the following hypothetical example of a integrated paper mill having 40,000 tonnes capacity :

Therefore, the variable cost is 60% of the total cost, fixed being 40%.

Then there is 'gross profit margin', which is the excess of sales realisations over the total cost of production.

If there is any increase in production within a particular range, the extra cost for the additional production will only be to the extent of variable cost whereas the sales realisations will be to the

VARIABLE :	**Total cost Rs. in million**	**Cost/ Tonnes**	**% of total cost excluding depreciation**
Basic Raw Materials (Bamboo & Wood)	10.54	264	17
Chemicals & Dyes	12.40	310	20
Power & Fuel	9.92	248	16
Packing & Freight	4.34	108	7
	37.20	930	60

FIXED :	**Total Cost Rs. in million**	**Cost/ Tonnes**	**% of total cost excluding depreciation**
Salaries & Wages	12.40	310	20
Interest	4.34	109	7
Administrative & Misc. Expenses	4.34	108	7
General Stores & Spares	3.72	93	6
	24.80	620	40
	62.00	1550	100

full extent. Hence, the addition to the profits for such additional production will not only be the usual profit margin but also the fixed cost. These two coupled together is termed as 'Contribution'.

Assuming in this case that the average realisation of paper is Rs. 2,100 per tonne and allowing say, 9% towards commission and discount, the net realisations will be Rs. 1,910 per tonne. Since its cost of production is Rs. 1,550 per tonne, the gross profit per tonne is Rs. 360. Further, considering that the unit increases its production from 40,000 to 40,500 tonnes, its profitability will work out as follows:

Production in Tonnes	40,000	40,500
	Rs. in mil.	Rs. in mil.
Net realisation @ 1,910 per tonne	76.40	77.36
Less : Variable Cost @ Rs. 930 per tonne	37.20	37.67
Contribution	39.20	39.69
Less : Fixed Cost	24.80	24.80
Gross Profit	14.40	14.89

Therefore, additional profit for 500 tonnes : Rs. 4,90,000.

i.e. additional profit per tonne : Rs. 980.

Thus, for the additional production, the profit is as large as Rs. 980 per tonne instead of Rs. 360 as discussed earlier becauee of non-addition in fixed cost which otherwise would be Rs. 620 per tonne.

This can also be expressed as under :
Sales Price = Variable Cost + Fixed Cost + Profits
Or, $S = V + F + P$.
But since fixed cost plus profit is contribution (C)
$S = V + C$ or, $C = S - V$
i.e. $C = 1910 - 930 =$ Rs. 980.

Since the fixed cost component itself is 40% of the total cost, it is a special feature that any additional production within a particular range, will result in substantial advantage. In certain circumstances it is found economical even to sacrifice slight efficiency to get higher production as long as there is overall advantage.

PRODUCTWISE PROFIT RECKONER:

It is a sort of statement showing the productwise profitability on time basis, whether it is per hour, per shift or per day of 24 hours because 'time' is the ultimate limiting factor for paper machines. It should never be on per tonne basis because the latter will rather tend to misguide. For example, if a product of 52 GSM gives a profit of Rs. 500 per tonne and that of 80 GSM Rs. 400 per tonne, if the comparison is on per tonne basis prima facie, it appears that the product of 52 GSM is more profitable. But, if it is taken into account that the production of 52 GSM will only be 40 tonnes per day whereas it is 70 tonnes in case of 80 GSM, the profitability in the former will only be Rs. 20,000 per day, in comparison to Rs. 28,000 in the latter. Therefore, producing 80 GSM is more profitable. This is entirely a reverse picture than the earlier interpretation.

While drawing out such Chart, cost upto a common process from cost point of view can be considered at the same rates for all such relevant products and thereafter the additions can be made for special chemicals.

A general proforma of summarised profit reckoner is given as Chart I which may be further modified to suit one's own requirement :

These types of Charts will be very helpful in periodical production and profit planning. They also have flexibility to incorporate any changes whether in variable cost, fixed cost or sale price. These Charts can also be further manipulated to select the best product mix when there are certain limiting or key factors in an unit.

CHART — I

Product	GSM	Production/ Day	Variable Cost/ Tonne	Variance Cost/ Day	Fixed Cost/ Day	Total Cost/ Day	Realisations Per Tonne	Realisations Per Day	Gross Profit Per Day
A									
B									
C									
D									
etc.									

CONSIDERATION OF LIMITING FACTOR IN PRODUCTION PLANNING

In every mill, there is bound to be one or other limiting factor, if not more, for example, the pulp supply may be a limiting factor for a particular mill whereas the availability of the raw material may be the limitation for the another unit and paper machine itself may be the limitation for some other unit. In such units, making the best utilisation of the limiting factor for optimum profits should be the main criterion in production planning. This can best be discussed with an example. The following assumptions may be noted for the purpose :

a) There are two paper machines in the Mill;
b) Each machine can produce five varieties i.e. A, B, C, D, E, on Machine I and 1, 2, 3, 4, 5 on Machine II; and
c) Pulp supply is limited to the extent of 110 tonnes a day.

Sales Restrictions is the other major limiting factor, which is being separately discussed at a later stage.

The other normal performances may be assumed as follows :

MACHINE I

Product (a)	Paper Prod. per day in tonnes (b)	Pulp — Requirement (c)	Per day Profits Rs. (d)
A	50	90%	20,000
B	60	84%	33,000
C	70	85%	28,000
D	90	80%	34,000
E	70	85%	30,000
MACHINE II			
1	40	90%	25,000
2	50	88%	40,000
3	60	84%	35,000
4	70	76%	48,000
5	80	82%	50,000

To know just at a glance the effect on limiting factor and profits from each of the possible combinations, another reckoner as given in Chart II will have to be prepared.

Since the pulp supply is limited to the extent of 110 tonnes, there are certain product combinations bold in Chart II, which cannot be produced for want of sufficient pulp. All the same, producing such mix cannot be said to be impossible as there are certain alternatives to cope up to the short supply of pulp, say,

(a) to use purchased paper cuttings; and

(b) to reduce the paper production to some extent by reducing the speeds of the machines.

To simplify the calculations, select the most economical alternative. Suppose there are only above two alternatives and the substitution by purchased paper cuttings costs more by Rs. 600 per tonne whereas the loss by reducing the production for each tonne would be Rs. 980 as calculated earlier. Therefore assuming that the purchased cutting to paper ratio is 1 to 1, it is advisable to purchase pulp and maintain full production than reducing the rate of production.

CHART — II

MACHINE I

a) Product	A	B	C	D	E
b) Paper Production/day in tonnes	50	60	70	90	70
c) Pulp required	90%	84%	85%	80%	85%
d) Pulp required per day	45	50	59	72	59
e) Per day profits ('000)	20'	33'	28'	34'	30'

MACHINE II

a	b	c	d	e ('000)	Pulp	Prof.	Pulp	Prof.	Pulp	Prof.	Pulp	Prof	Pulp	Prof.
1	40	90%	36	25'	81	45'	86	58'	95	53'	108	59'	95	55'
2	50	88%	44	40'	89	60'	94	73'	103	68'	**116**	74'	103	70'
3	60	84%	50	35'	95	55'	100	68'	109	63'	**122**	69'	109	65'
4	70	76%	53	48'	98	68'	103	81'	**112**	78'	**125**	82'	**112**	78'
5	80	82%	64	50'	109	70'	**114**	83'	**123**	78'	**136**	84'	**123**	80'

NOTE : All bold numbered product combinations denotes more pulp requirement than the maximum possible supply of 110 tonnes.

Prof. = Profits.

CHART — III

Product Mix	Pulp req.	Profits/ Day	Pulp req. over 110 T	Addl. cost for purchased pulp @ Rs. 600 per tonne	Revised profit-ability per day
(i)	(ii)	(iii)	(iv)	(v)	(vi)
1A	81	45,000	...	...	45,000
1B	86	58,000	...	...	58,000
1C	95	53,000	...	...	53,000
1D	108	59,000	...	...	59,000
1E	95	55,000	...	...	55,000
2A	89	60,000	...	...	60,000
2B	94	73,000	...	...	73,000
2C	103	68,000	...	...	68,000
2D	116	74,000	6	−3600	70,000
2E	103	70,000	...	...	70,000
3A	95	55,000	...	...	55,000
3B	100	68,000	...	...	68,000
3C	109	63,000	...	...	63,000
3D	122	69,000	12	−7200	62,000
3E	109	65,000	...	...	65,000
4A	98	68,000	...	...	68,000
4B	103	81,000	...	...	81,000
4C	112	76,000	2	−1200	75,000
4D	125	82,000	15	−9000	73,000
4E	112	78,000	2	−1200	77,000
5A	109	70,000	...	...	70,000
5B	114	83,000	4	−2400	81,000
5C	123	78,000	13	−7800	70,000
5D	136	84,000	26	−15600	68,000
5E	123	80,000	13	−7800	72,000

Now, extracting the pulp requirement and profit per day for each of the mix from Chart II, eliminate the additional cost for purchasing the paper cuttings wherever necessary. The ultimate profitability will then be as shown in Col. (vi) of Chart III.

From Chart III, re-arrange all the product combinations in descending order of ultimate profitability as given in Chart IV, for further study :

CHART — VI

Product mix	Profits/day
4B	81
5B	81
4E	77
4C	75
2B	73
4D	73
5E	72
5A	70
2D	70
5C	70

Product mix	Profits/per day
2E	70
4A	68
3B	68
2C	68
5D	68
3E	65
3C	63
3D	62
2A	60
1D	59
1B	58
1E	55
3A	55
1C	53
1A	45

CONSIDERATION OF MARKET RESTRICTIONS IN PRODUCTION PLANNING

Though the paper industry enjoys, at present, a sellers market, there are a number of restrictions from sales point of view e.g. compulsory production of Government Orders, Cultural Papers, Export Orders, etc. Besides, for a particular qualities there may not be sufficient demand in the market. Moreover certain products will have to be produced to maintain the past good relations with the particular customers or as a safeguard for future. For all these factors, therefore, sufficient provision will have to be made while setting out the pattern of production.

For the purpose, let us assume that the following minimum and maximum constraints will have to be considered every month :

MACHINE I

Product	Min. Tonnes	Max. Tonnes
A	300	NR
B	350	600
C	200	NR
D	NR	600
E	NR	800

MACHINE II

Product	Min. Tonnes	Max. Tonnes
1	100	200
2	100	200
3	200	200
4	NR	1000
5	NR	NR

(NR = No Restriction)

Now, with the help of Chart IV, let us select the best matching pattern for the month taking into account all the above minimum and maximum constraints with the aim to get the best possible profits.

(See Chart VI, VII Annexure I & II alongside)

Thus in selecting the best pattern, the emphasis has been shifted from overall paper production point of view to the pulp supply limitation. All the calculations are based on the key factor and the profits would be Rs. 2.06 million. For a moment, let us think what pattern would have been selected if the calculations were based on paper production point of view. In that case, it would be quite reasonable to assume the paper production limit of 130 tonnes a day. The combination of products making more than 130 tonnes paper would have been straight-away

CHART — VI

MACHINE I					MACHINE II				
Product	Quantity Tonnes	Per day prod.	No. of days	Justification	Product	Quantity Tonnes	Per day prod.	No. of days	Justification
A	300	50	6.0	Minimum requirement	5	480	80	6.0	Best match with A
B	350	60	5.8	Minimum requirement	4	405	70	5.8	Best match with B
C	200	70	2.9	Minimum requirement	4	205	70	2.9	Best match with C
D	225	90	2.5	Best match with 1	1	100	40	2.5	Minimum requirement
D	180	90	2.0	Best match with 2	2	100	50	2.0	Minimum requirement
E	230	70	3.3	Refer Note below	3	200	60	3.3	Minimum requirement
B	200	60	3.3	Refer Note below	4	230	70	3.3	Best match with B on M/c. I
B	50	60	0.8	Since 4B is the best match complete the maximum limit of B with 4 on M/c. II	4	55	70	0.8	Best match with B on M/c. I
E	100	70	1.4	After 4B, next best available match is E with 4 on M/c. II	4	100	70	1.4	After 4B, best match with E on M/c. I
Shut	...	...	2.9			...	...	2.0	
	1835		30.0			1875		30.0	

NOTE: With 3 on Machine II, B is the best match on Machine I. But the orders of B are limited to the extent of 600 tonnes per month. If these orders of B are completed, next best is 4E. But B can also be utilised, with product 4. In that case with 3, E can be used as 3E is the best match after 3B. Since the loss by changing over from 3B to 3E is Rs. 3,000 per day whereas the advantage of having 4B instead of 4E gets a gain of Rs. 4,000 the pattern that must be followed is E with 3 and B with 4. For the same reason 2 is to be preferred with D instead of B.

rejected and the derived pattern would be as given in annexure II based on the product matchings detailed in annexure I with the similar sales restrictions. The profit in this case will only be Rs. 1.97 million and the capacity has not been utilised to the maximum extent.

Thus by shifting over the emphasis on the key factor of the given example, the profits have improved by Rs. 90,000 a month or over one Million Rupees a year.

Moreover, if due consideration is not given to the key factor, it may create certain complications and may, in fact, disturb the entire pattern of production. In certain cases, the product mix may suit from overall paper production limit, but may need more pulp than the available limit.

In similar way, the profits can be optimised by setting the best pattern based on any limiting factor in a mill together with due consideration of all the sales restrictions.

However, in practice, there may be a large number of products with more number of machines, drawing the Charts of which may manually be very difficult and quite lengthy. Such cases can easily be solved with help of Computers.

Now if summarised, the final monthly production pattern **will be**:

CHART VII

MACHINE I					MACHINE II				
Product	Quantity Tonnes	No. of days	Profit/ day Rs.	Total profits Rs.	Product	Quantity Tonnes	No. of Days	Profit/ Day Rs.	Total Profits Rs.
A	300	6.0	20,000	1,20,000	1	100	2.5	25,000	62,500
B	600	9.9	33,000	3,26,700	2	100	2.0	40,000	80,000
C	200	2.9	28,000	81,200	3	200	3.3	35,000	1,15,500
D	405	4.5	34,000	1,53,000	4	995	14.2	48,0000	6,81,600
E	330	4.7	30,000	1,41,000	5	480	6.0	50,000	3,00,000
Shut	—	2.0	—	—	Shut	—	2.0	—	—
	1,835	30.0		8,21,900		1,875	30.0		12,39,600

Total Production : Rs. 3,710 Tonnes
Total Profits : Rs. 20,61,500 Tonnes

FINAL PATTERN

ANNEXURE II

MACHINE I					MACHINE II				
Product	Tonnes	Days	Profit/ Day Rs.	Total Profits Rs.	Product	Tonnes	Days	Profit/ Day Rs.	Total Product Rs.
A	575	11.5	20,000	2,30,000	1	135	3.4	25,000	85,000
B	600	10.0	33,000	3,30,000	2	200	4.0	40,000	1,60,000
C	200	2.9	28,000	81,200	3	200	3.3	35,000	1,15,500
D	225	2.5	34,000	85,000	4	495	7.1	48,000	3,40,800
E	75	1.1	30,000	33,000	5	815	10.2	50,000	5,10,000
Shut	—	2.0	—	—	Shut	—	2.0	—	—
	1,675	30.0		7,59,200		1,845	30.0		12,11,300

Total Production : 3,520
Total Profits : 19,70,500

ANNEXURE I

MACHINE I				MACHINE II			
Product	Quantity Tonnes	Prod./ day	No. of Days	Product	Quantity Tonnes	Prod./ day	No. of Days
A	300	50	6.0	5	480	80	6.0
B	350	60	5.8	4	405	70	5.8
C	200	70	2.9	2	100	50	2.0
D	225	90	2.5	1	35	40	0.9
B	120	60	2.0	1	100	40	2.5
**B	130	60	2.2	2	100	50	2.0
E	75	70	1.1	3	200	60	3.3
			22.5				22.5
A	65	50	1.3	4	90	70	1.3
A	210	50	4.2	5	335	80	4.2
Shut	—	—	2.0		—	—	2.0
	1,675		30.0		1,845		30.0

** Within the given limits B is the best match for product 3. But as the maximum limit for the product is 600 tonnes, only 130 tonnes further can be made with product 3 and rest will have to be matched with E.

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