
MACPHERSON REFRIGERATION LIMITED

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In October, Linda Metzler, newly appointed production planning manager of MacPherson Refrigeration Limited (MRL) of Stratford, Ontario, was formulating the production plan for the year beginning on January 1. She had to submit the plan to the plant's general manager by the end of the month.

BACKGROUND

MRL had sales of about \$28.5 million. The company began in Stratford almost 30 years ago, specializing in commercial refrigeration. Ten years ago the company opened a new 300,000 square foot plant in Stratford and diversified into consumer refrigeration. Subsequently, MRL added air conditioners to its freezer and refrigerator lines. The company sold its Hercules brand appliances through independent furniture and appliance stores in southern Ontario.

THE STRATFORD PLANT

In the past 20 years, manufacturing efficiency at the plant had increased dramatically through changes in both process design and assembly technology. During this time, annual output per worker had increased from about 240 to 450 appliances; it was expected to be about 480 appliances next year. Although the Canadian market was too small to allow the productivity levels of American appliance manufacturers, MRL was considered to be relatively efficient by Canadian standards.

THE PLANNING PROCESS

Each year in September the marketing and sales department produced a forecast of appliances by month for the next year. The production planning department used these forecasts to plan production for the next year. The first step in the planning process was to construct an aggregate production plan. This plan consisted of planned gross production by month for the year and did not indicate numbers of specific appliance types, sizes, or models to be made each month but, as the name indicates, was an aggregate. Linda Metzler's task in October was to construct this aggregate plan. As the production periods approached later in the year, master production plans would be formulated which would be specific regarding appliance type, model number, etc.

Exhibits 1–4 present the September forecast showing the expected seasonal fluctuations and the aggregate number of appliances to be shipped each month. Linda knew that, although there would be significant variation of specific appliance types within each month, each type of appliance required roughly similar materials and labour resources. Thus, for aggregate planning purposes, the number of appliances to be shipped would be sufficient.

THE AGGREGATE PLAN

In preparation for her decision, Linda gathered the following information:

1. The Stratford plant had the physical capacity to make only 13,000 appliances per month.

Month	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Totals
Production Plan														
Shipment Forecast		4,400	4,400	6,000	8,000	6,600	11,800	13,000	11,200	10,800	7,600	6,000	5,600	95,400
Production Plan		8,440	8,440	8,440	8,440	8,440	8,440	8,440	8,440	8,440	8,440	8,440	8,440	101,280
Shipments		4,400	4,400	6,000	8,000	6,600	11,800	13,000	11,200	10,800	7,600	6,000	5,600	95,400
Inventory ¹	240	4,280	8,320	10,760	11,200	13,040	9,680	5,120	2,360	0	840	3,280	6,120	75,000
Extraordinary Labour Costs														
Number of Workers ²	160	211	211	211	211	211	211	211	211	211	211	211	211	2,532
Hirings		51	0	0	0	0	0	0	0	0	0	0	0	51
Layoffs		0	0	0	0	0	0	0	0	0	0	0	0	0
Worker Months Overtime		0	0	0	0	0	0	0	0	0	0	0	0	0
Cost of Alternative 1														
Hiring Costs		$51 \times 1,800 = 91,800$												
Layoff Costs		$0 = 0$												
Inventory Holding Costs		$75,000 \times 8 = 600,000$												
Labour Costs														
Regular		$2,532 \times 2,400 = 6,076,800$												
Overtime		$0 = 0$												
Total Costs		\$6,768,600												

Exhibit 1 Level Production to Meet Peak Demand

1. On December 31, finished goods inventory was predicted to be 240 units.
2. On December 31, the workforce was predicted to be 160 workers.

Month	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Totals
Production Plan														
Shipment Forecast		4,400	4,400	6,000	8,000	6,600	11,800	13,000	11,200	10,800	7,600	6,000	5,600	95,400
Production Plan		4,160	4,400	6,000	8,000	6,600	11,800	13,000	11,200	10,800	7,600	6,000	5,600	95,160
Shipments		4,400	4,400	6,000	8,000	6,600	11,800	13,000	11,200	10,800	7,600	6,000	5,600	95,400
Inventory ¹	240	0	0	0	0	0	0	0	0	0	0	0	0	0
Extraordinary Labour Costs														
Number of Workers ²	160	199	199	199	199	199	199	199	199	199	199	199	199	2,388
Hirings		39	0	0	0	0	0	0	0	0	0	0	0	39
Layoffs		0	0	0	0	0	0	0	0	0	0	0	0	0
Worker Months Overtime		0	0	0	1	0	96	126	81	71	0	0	0	375
Cost of Alternative 2														
Hiring Costs		$39 \times 1,800 =$	70,200											
Layoff Costs		$0 =$	0											
Inventory Holding Costs		$0 =$	0											
Labour Costs														
Regular		$2,388 \times 2,400 =$	5,731,200											
Overtime		$375 \times 3,300 =$	1,237,500											
Total Costs			\$7,038,900											

Exhibit 2 Chase Production Plan With Constant Workforce and Overtime

1. On December 31, finished goods inventory was predicted to be 240 units.
2. On December 31, the workforce was predicted to be 160 workers.

Month	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Totals
Production Plan														
Shipment Forecast		4,400	4,400	6,000	8,000	6,600	11,800	13,000	11,200	10,800	7,600	6,000	5,600	95,400
Production Plan		4,160	4,400	6,000	8,000	6,600	11,800	13,000	11,200	10,800	7,600	6,000	5,600	95,160
Shipments		4,400	4,400	6,000	8,000	6,600	11,800	13,000	11,200	10,800	7,600	6,000	5,600	95,400
Inventory ¹	240	0	0	0	0	0	0	0	0	0	0	0	0	0
Extraordinary Labour Costs														
Number of Workers ²	160	199	110	150	200	165	295	325	280	270	190	150	140	2,379
Hirings		0	6	40	50	0	130	30	0	0	0	0	0	256
Layoffs		56	0	0	0	35	0	0	45	10	80	40	10	276
Worker Months Overtime		0	0	0	0	0	0	0	0	0	0	0	0	0
Cost of Alternative 3														
Hiring Costs		$256 \times 1,800 =$		460,800										
Layoff Costs		$276 \times 1,200 =$		331,200										
Inventory Holding Costs		$0 =$		0										
Labour Costs		$2,379 \times 2,400 =$		5,709,600										
Regular		$0 =$		0										
Overtime		$0 =$		0										
Total Costs		\$6,501,600												

Exhibit 3 Chase Production Plan With Varying Workforce

1. On December 31, finished goods inventory was predicted to be 240 units.
2. On December 31, the workforce was predicted to be 160 workers.

Month	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Totals
Production Plan														
Shipment Forecast		4,400	4,400	6,000	8,000	6,600	11,800	13,000	11,200	10,800	7,600	6,000	5,600	95,400
Production Plan														
Shipments														
Inventory ¹	240													
Extraordinary Labour Costs														
Number of Workers ²	160													
Hirings														
Layoffs														
Worker Months Overtime														
Cost of Alternative 4														
Hiring Costs														
Layoff Costs														
Inventory Holding Costs														
Labour Costs														
Regular														
Overtime														
Total Costs														

Exhibit 4 Aggregate Plan for Macpherson Refrigeration Limited

1. On December 31, finished goods inventory was predicted to be 240 units.
2. On December 31, the workforce was predicted to be 160 workers.

2. On October 1, MRL employed 160 hourly paid unionized production workers. Their two year contract, signed in February of last year, called for an increase of \$0.75 per hour effective next January 1, bringing the average hourly rate to \$10.50. With fringe benefits, the monthly cost to MRL would be about \$2,400 per worker. Under the agreement, overtime was 1.5 times the regular hourly rate but, because not all fringes were affected, a worker-month of overtime cost about \$3,300. The standard work week was 40 hours. The aggregate plan in effect until December 31 called for a total production workforce of 160 at that time.
3. The personnel department estimated that hiring, training, and related expenses would amount to \$1,800 per worker. It also estimated that severance and other layoff expenses would cost a total of \$1,200 per worker.
4. The accounting department predicted that it would cost about \$8 to hold an appliance in inventory for a month during the next year. Raw materials were readily available from regional sources on short notice. The current aggregate plan, supported by marketing's most recent revised forecasts and the master production schedule, predicted an inventory of 240 finished units on December 31.
5. Although MRL manufactured some parts and subassemblies, the plant was primarily a final assembly operation with a throughput time of about three days. The company used an MRP-based planning system. For aggregate planning purposes, management had found that it was adequate to assume that all worker hours scheduled in a particular month would contribute directly to output in the same month. Similarly, they had learned from experience that they would not have to consider any special allowances for learning.
6. There appeared to be three basic tools available to meet demand fluctuations, each of which involved both quantitative and qualitative tradeoffs:
 - building inventory to meet peaks
 - using overtime
 - hiring and laying off workers

THE ALTERNATIVES

Linda identified three alternatives the company could follow to meet forecasted demand:

1. The production level and the workforce could be held constant throughout the year at a level sufficient to meet the peak demand period. In periods of low demand inventory would be accumulated and would be drawn down during peak demand periods. Linda was attracted by the protection this plan offered against unforeseen demand changes. This plan is one example of a level strategy and is shown in Exhibit 1.
2. The production level could vary to meet demand with a constant workforce by the use of overtime in peak months and restricted output in slow months; it is an example of a chase strategy and is shown in Exhibit 2. The workforce would be held at just the number to meet average monthly requirements. MRL would incur no inventory carrying costs with such a scheme. However, Linda wondered if excessive overtime might lead to lower efficiency, or if restricted production might promote poor work habits and low morale.
3. Some of these potential problems could be overcome by a strategy that met demand by varying workforce levels. Linda's calculations showed this to be the cheapest of the three alternatives (see Exhibit 3). However, she was well aware that union relations and employee morale could be adversely affected by frequent layoffs. As well, hiring and training new employees brought their own headaches, especially in a limited labour market such as existed in Stratford.

THE DECISION

Linda knew that these three very different plans were by no means the only feasible ones available. She realized that her decision on an aggregate plan would involve both quantitative and qualitative trade-offs. One thought nagged in the back of her mind: no matter which plan she chose, how would she know if a better one existed? She decided to start by filling out her blank form (Exhibit 4) one more time.