Aggregate Planning: Example

(Adapted from Chase and Aquilano, "Fundamentals of Operations Management", Irwin Pub., 1991)

Example: Introduction

A vacuum cleaner manufacturer tries to “plan ahead” in order to effectively address the seasonal variation appearing in the annual demand of its products. A planning horizon of 6 months is used. The (aggregate) demand forecast for the next six months along the number of working days are as follows:

Month	Demand Forecast	No. of Working Days
Jan.	1,800	22
Febr.	1,500	19
March	1,100	21
April	900	21
May	1,100	22
June	1,600	20
	Total: 8,000 units	Total: 125 Days

Example: Introduction (cont.)

The associated cost break-down is as follows:

Cost Item	Cost($)
Material	$100 per unit
Inventory Holding	$5 per unit per month
Marginal Stockout	$10 per unit per month
Marginal Cost of Subcontracting	$20 per unit
(Cost of buying less material costs)	
Hiring and Training	$1000 per worker
Layoff	$1500 per worker
Regular Labor cost per hour	$15 per employee per hour
Overtime labor cost per hour	$20 per employee per hour

Example: Introduction (cont.)

Starting and Operating Conditions:

Current Inventory	400 units
Current Workforce	38 workers
Labor hours per unit	5 employee-hours/unit
Regular labor time per employee per day	8 hours
Inventory at the end of each month	25% of coresp. demand

The tabular approach: Computing net requirements

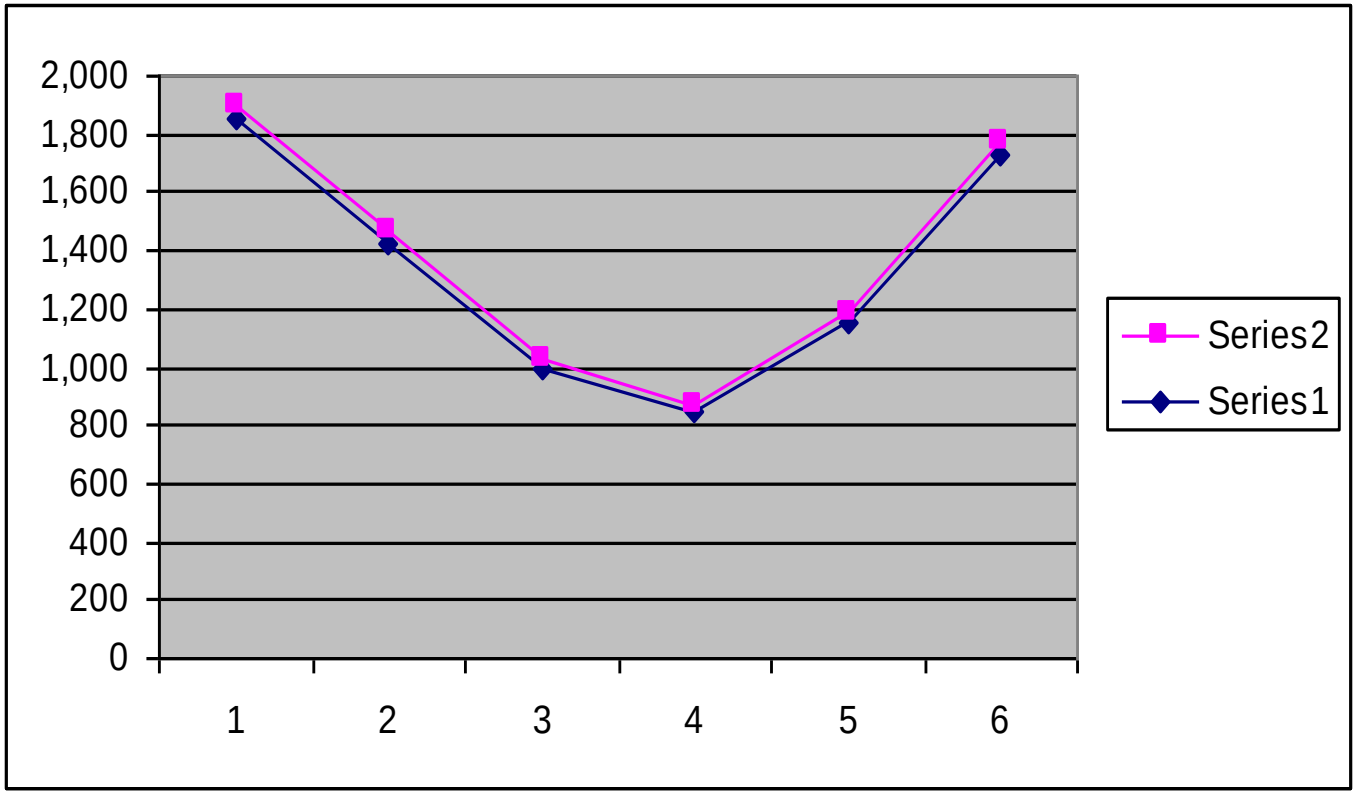
Month	Beg. Inv.	Forc. Dem.	End. Inv.	Prod. Req.
Jan.	400	1,800	450	1,850
Febr.	450	1,500	375	1,425
March	375	1,100	275	1,000
April	275	900	225	850
May	225	1,100	275	1,150
June	275	1,600	400	1,725
				8,000

Plan 1: Demand Chasing

Produce exactly the quantities required for each period through regular labor, by varying the workforce size.

Month	Prod. Req.	Req. Labor Hours	Work Days	Workers	PC	WC	HC	FC
Jan.	1,850	9,250	22	53	185000	139920	15000	0
Febr.	1,425	7,125	19	47	142500	107160	0	9000
March	1,000	5,000	21	30	100000	75600	0	25500
April	850	4,250	21	25	85000	63000	0	7500
May	1,150	5,750	22	33	115000	87120	8000	0
June	1,725	8,625	20	54	172500	129600	21000	0
					800000	602400	44000	42000
							TC=	1488400

Plan 1: Demand Chasing (cont.)

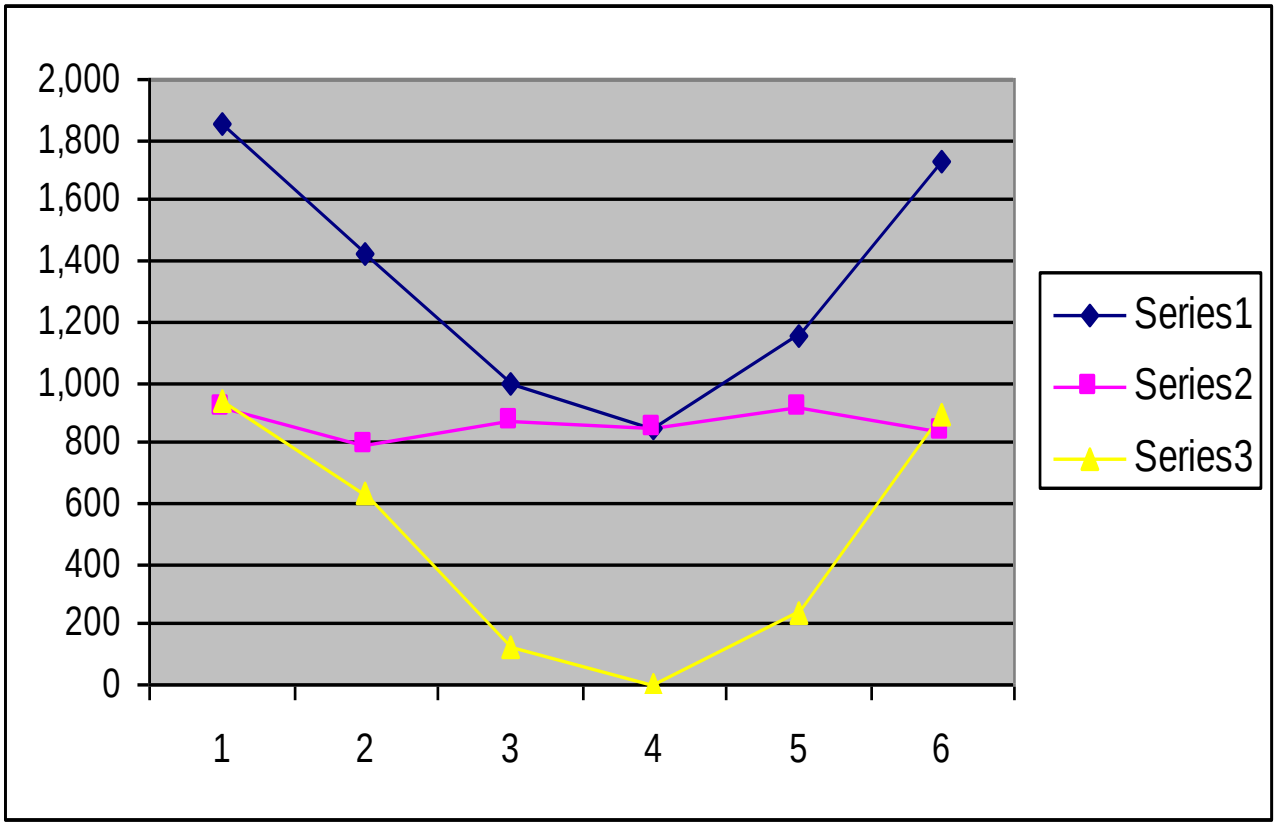


Plan 2: Minimum Production Workforce + Subcontracting

- Adjust the workforce so that the minimal monthly demand is met through regular labor.
- Subcontract all excess demand.

Month	Prod. Req.	Req. Labor Hours	Work Days	Workers	Int. Prod.	Subcontr. Quantity	PC	WC	SC	FC
Jan.	1,850	9,250	22	26	915	935	91500	68640	112200	18000
Febr.	1,425	7,125	19	26	790	635	79000	59280	76200	0
March	1,000	5,000	21	26	874	126	87400	65520	15120	0
April	850	4,250	21	26	850	0	85000	65520	0	0
May	1,150	5,750	22	26	915	235	91500	68640	28200	0
June	1,725	8,625	20	26	832	893	83200	62400	107160	0
							517600	390000	338880	18000
									TC=	1264480

Plan 2: Minimum Production Workforce + Subcontracting

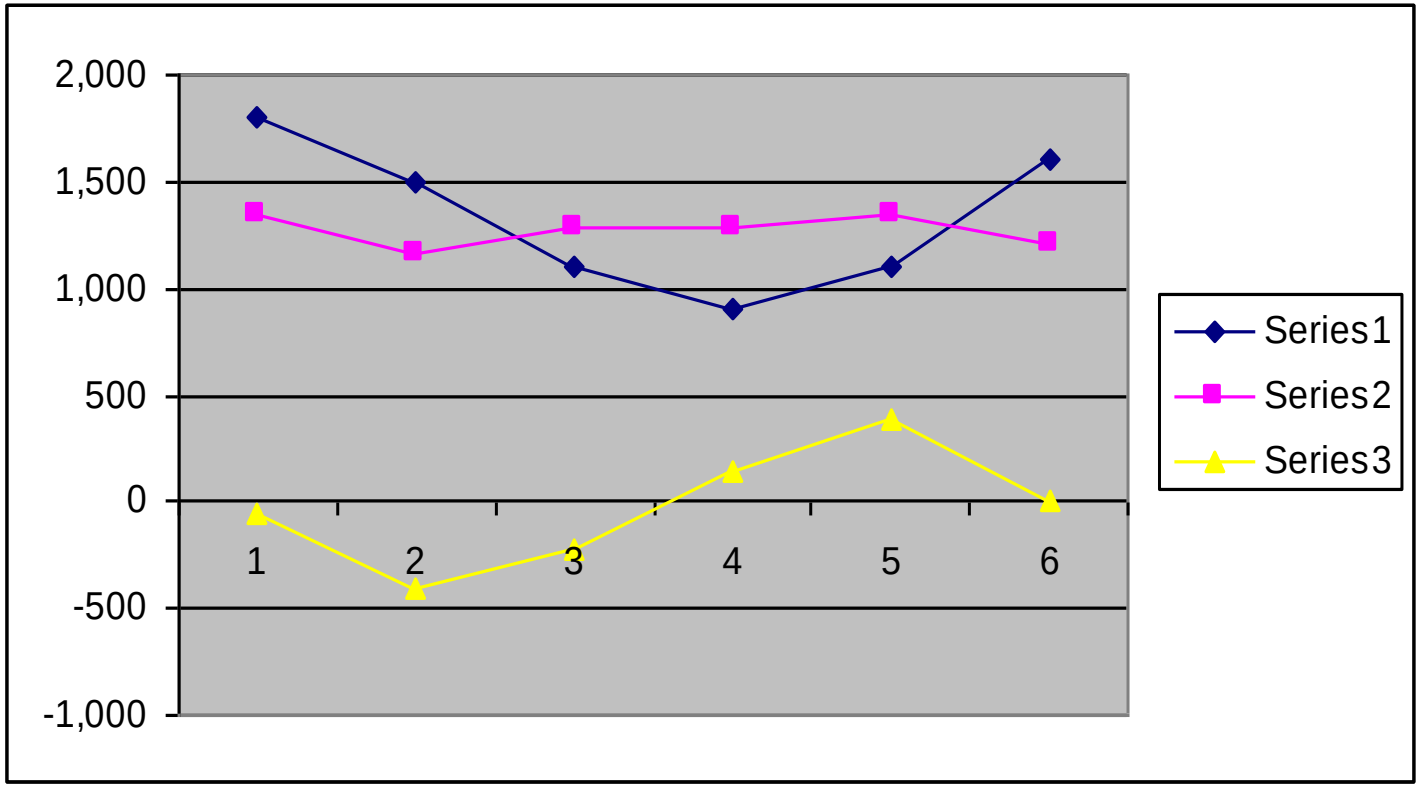


Plan 3: Anticipatory (Seasonal) Inventories + Backlogging

- Employ the minimal workforce level that can cover the total production requirements over the considered planning horizon, by working only regular hours.
- Take care of the demand fluctuations by building anticipatory inventories and/or backlogging excess demand.

Month	Prod. Req.	Work Days	Workers	Act. Prod.	Inventory	Backlogs	PC	WC	IC	BC
Jan.	1,800	22	38	1338	0	62	133800	100320	0	620
Febr.	1,500	19	38	1155	0	407	115500	86640	0	4070
March	1,100	21	38	1277	0	230	127700	95760	0	2300
April	900	21	38	1277	147	0	127700	95760	735	0
May	1,100	22	38	1338	385	0	133800	100320	1925	0
June	1,600	20	38	1215	0	0	121500	91200	0	0
	8000	125		7600			760000	570000	2660	6990
									TC=	1339650

Plan 3: Anticipatory (Seasonal) Inventories + Backlogging (cont.)



Analytical Approach:
A Linear Programming Formulation

$$\min TC = \sum_t \left(PC_t*P_t+WC_t*W_t+OC_t*O_t+HC_t*H_t+FC_t*F_t+ SC_t*S_t+IC_t*I_t+BC_t*B_t \right)$$

s.t.

$$\forall t,\ P_t+I_{t-1}+S_t = (D_t-B_t)+B_{t-1}+I_t$$

$$\forall t,\ W_t = W_{t-1}+H_t-F_t$$

$$\forall t,\quad 5*P_t \le 8*WD_t*W_t+O_t$$

$$\left(\forall t,\ I_t \ge 0.25*D_t \right)$$

$$B_6 = 0$$

$$\forall t,\ P_t, W_t, O_t, H_t, F_t, S_t, I_t, B_t \ge 0$$