

Operations & Supply Planning
PGDM 2018-20

Sales and Operations Planning

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Matching Supply with Demand



Typical executive staff meeting

President: This shortage situation is terrible. When will we ever get our act together? Whenever business is good, we run out of product and our customer service is lousy.

VP Operations: I'll tell you when. When we start to get some decent forecasts from the Sales Department...

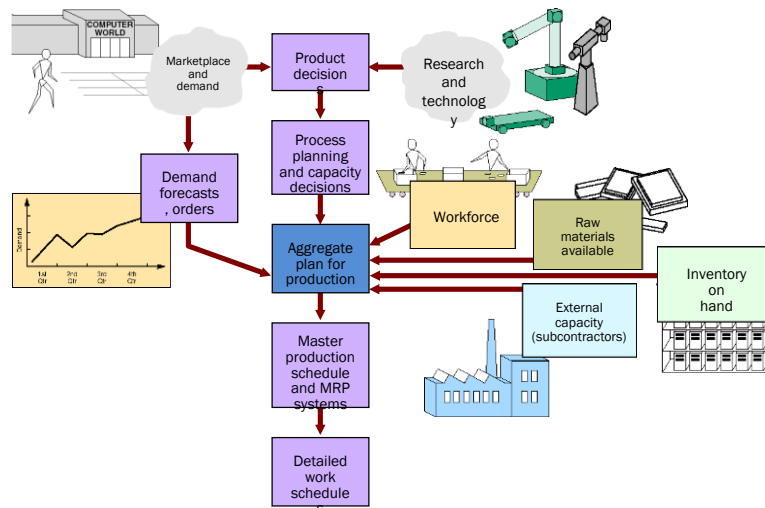
VP Sales (interrupting): Wait a minute. We forecasted this upturn.

VP Operations: ... in time to do something about it. Yeah, we got the revised forecast...four days after the start of the month. By then it was too late

VP Sales: I could have told you months ago. All you had to do was ask!

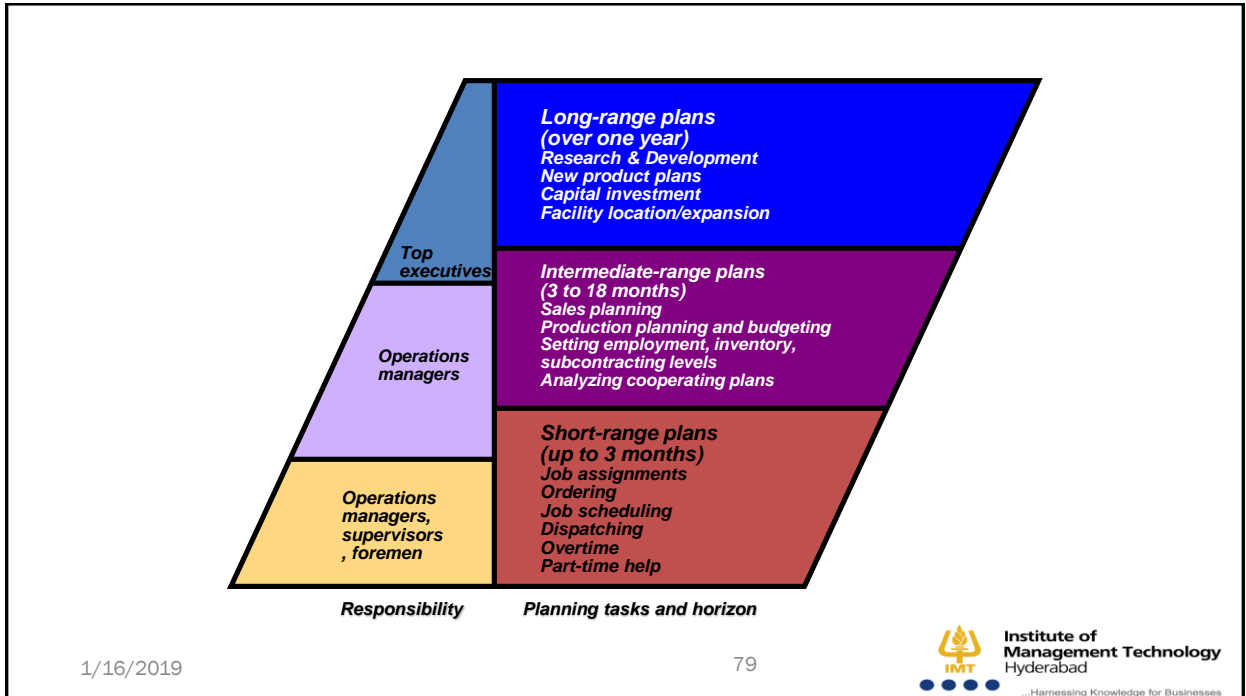
VP Finance: I'd like to be in on those conversations. We've been burned more than once by building inventories for a business upturn that doesn't happen. Then we get stuck with tons of inventory and run out of cash!

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Aggregate Operations Planning

- Amount of resources to be committed in each period
- Rate at which goods and services need to be produced in each period
- Inventory to be carried forward from one period to the next
- Is in terms of standardized aggregate units

The Aggregate Operations Plan

- Main purpose: Specify the optimal combination of
 - Production rate (units completed per unit of time)
 - Workforce Level (number of workers)
 - Inventory on Hand (inventory carried from previous period)
- Product group or broad category (Aggregation)
- This planning is done over an intermediate range planning period of 3 to 18 months

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Problem statement

Given the demand forecast F_t for each period t in the planning horizon that extends over T periods, determine the production level P_t , inventory level I_t and workforce level W_t for periods $t = 1, 2, 3, \dots, T$ that minimize the relevant costs over the planning horizon.

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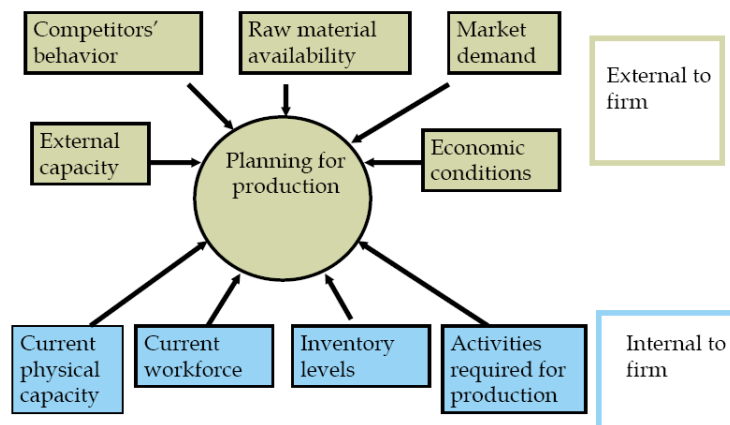
Relevant costs

- Basic production costs
- Cost associated with changes in the production rate
- Inventory holding costs
- Backorder costs
- Shortage costs

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Inputs to the production planning system



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Why do you need an Aggregate Planning

- Demand Fluctuations
- Capacity Fluctuations
- Difficulty level of altering operation rates
- Benefits of multi-period planning

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Managing Demand

- Reservation systems
- Influencing demand
 - Promoting off peak demand
 - Backordering
 - Counter seasonal product or service mixings
- Overbooking

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Managing Supply

- Inventory based adjustments
 - Build inventory during lean periods
 - Backorder/Stock out/backlog
- Capacity Adjustment
 - Hiring/laying off workers
 - Varying shifts
 - Varying working hours
- Capacity augmentation alternatives
 - Sub-contract
 - Add new capacity
 - De-bottleneck

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Other ways of managing supply

- Increasing customer participation
- Creating adjustable capacity
- Sharing capacity
- Cross training employees
- Using part time employees

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Basic Strategies for AOP

Level Strategy



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Chase Strategy



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Level strategy

- Daily production is uniform
- Use inventory or idle time as buffer
- Stable production leads to better quality and productivity

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Chase strategy

- Match output rates to demand forecast for each period
- Vary workforce levels or vary production rate
- Favored by many service organizations



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Mixed Strategy

- A mixed strategy may be the best way to achieve minimum costs
- There are many possible mixed strategies
- Finding the optimal plan is not always possible

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DEMAND AND WORKING DAYS							
	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	TOTALS
Demand forecast	1,800	1,500	1,100	900	1,100	1,600	8,000
Number of working days	22	19	21	21	22	20	125
COSTS							
Materials			\$100.00/unit				
Inventory holding cost			\$1.50/unit/month				
Marginal cost of stockout			\$5.00/unit/month				
Marginal cost of subcontracting			\$20.00/unit (\$120 subcontracting cost less \$100 material savings)				
Hiring and training cost			\$200.00/worker				
Layoff cost			\$250.00/worker				
Labor hours required			5/unit				
Straight-time cost (first eight hours each day)			\$4.00/hour				
Overtime cost (time and a half)			\$6.00/hour				
INVENTORY							
Beginning inventory			400 units				
Safety stock			25% of month demand				

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Aggregate Planning – JC Company

	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE
Beginning inventory	400	450	375	275	225	275
Demand forecast	1,800	1,500	1,100	900	1,100	1,600
Safety stock (.25 × Demand forecast)	450	375	275	225	275	400
Production requirement (Demand forecast + Safety stock – Beginning inventory)	1,850	1,425	1,000	725	975	1,325
Ending inventory (Beginning inventory + Production requirement – Demand forecast)	450	375	275	225	275	400

January ending inventory becomes February beginning inventory.

Evaluate Alternative Plans

Produce to exact monthly production requirements by varying workforce size

Produce to meet expected average demand by maintaining a constant workforce

Produce to meet the minimum expected demand using a constant workforce and subcontract to meet additional requirements

Produce to meet expected demand for all but the first two months using a constant workforce and use overtime to meet additional output requirements

Plan 1: Exact Production; Vary Workforce

PRODUCTION PLAN 1: EXACT PRODUCTION; VARY WORKFORCE							
	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	TOTAL
Production requirement (from Exhibit 19.3)	1,850	1,425	1,000	850	1,150	1,725	
Production hours required (Production requirement × 5 hr/unit)	9,250	7,125	5,000	4,250	5,750		
Working days per month	22	19	21	21	22		
Hours per month per worker (Working days × 8 hr/day)	176	152	168	168	176		
Workers required (Production hours required/Hours per month per worker)	53	47	30	26	33	54	
New workers hired (assuming opening workforce equal to first month's requirement of 53 workers)	0	0	0	0	7	21	
Hiring cost	\$0	\$0	\$0	\$0	\$1,400	\$4,200	\$5,600
Workers laid off	0	6	17	4	0	0	
Layoff cost	\$0	\$1,500	\$4,250	\$1,000	\$0	\$0	\$6,750
Straight-time required	\$37,000	\$28,500	\$20,000	\$17,000	\$23,000	\$34,500	\$160,000
						Total cost	\$172,350

Production exactly matches requirements.

Workers are added or reduced as needed.

Plan 2: Constant Workforce; Vary Inventory and Stockout

PRODUCTION PLAN 2: CONSTANT WORKFORCE; VARY INVENTORY AND STOCKOUT							
	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	TOTAL
Beginning inventory	400	8	-276	-32	412	720	
Working days per month	22	19	21	21	22	20	
Production hours available (Working days hr/day × 40 workers)*	7,040	6,080	6,720	6,720	7,040	6,400	
(Production hours unit)	1,408	1,216	1,344	1,344	1,408	1,280	
(from Exhibit 19.3)	1,800	1,500	1,100	900	1,100	1,600	
Beginning inventory + Production - Demand forecast)	8	-276	-32	412	720	400	
Units short × \$5)	\$0	\$1,380	\$160	\$0	\$0	\$0	\$1,540
(from Exhibit 19.3)	450	375	275	225	275	400	
Units excess (Ending inventory - Safety stock) only if positive amount	0	0	0	187	445	0	
Inventory cost (Units excess × \$1.50)	\$0	\$0	\$0	\$281	\$668	\$0	\$948
Straight-time cost (Production hours available × \$4)	\$28,160	\$24,320	\$26,880	\$26,880	\$28,160	\$25,600	\$160,000
						Total cost	\$162,488

Number of workers is set to meet average demand over the time horizon. This then determines production rate and inventory/backorders.

Plan 3: Constant Low Workforce; Subcontract

PRODUCTION PLAN 3: CONSTANT LOW WORKFORCE; SUBCONTRACT							
	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	TOTAL
Production requirement (from Exhibit 19.3)	1,850	1,425	1,000	850	1,150	1,725	
Working days per month	22	19	21	21	22	20	
Production hours available (Working days × 8 hr/day × 25 workers)*	4,400	3,800	4,200	4,200	4,400	4,000	
Actual production (Production hours available/5 hr; per unit)	880	760	840	840	880	800	
Units subcontracted (Production requirement - Actual production)	970	665	160	10	270	925	
Subcontracting cost (Units subcontracted × \$20)	\$19,400	\$13,300	\$3,200	\$200	\$5,400	\$18,500	\$60,000
Straight-time cost (Production hours available × \$4)	\$17,600	\$15,200	\$16,800	\$16,800	\$17,600	\$16,000	\$100,000
						Total cost	\$160,000

Workforce sized to meet minimum demand (April).

*Minimum production requirement. In this example, April's minimum of 850 units. Number of workers required for April is $(850 \times 5) / (21 \times 8) = 25$.

Demand over minimum is met with subcontracting.