

FINITE PRODUCTION SCHEDULING

AT WELCH'S

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ENVIRONMENT

- Dynamic, uncertain demand - promotions
- Make-to-stock

Mfg. lead time

Forecast driven planning

Forecast errors and bias

Customer Service requirements

All combine to impose:

Dynamic safety stock requirements

- Dedicated production lines
- Two or more families per line

Family - defined by similar set-up times
and costs, similar production rates.

- Family set-ups dominate those of
individual products

CURRENT SCHEDULING

Inventory Planning Model (IPM) accounts for:

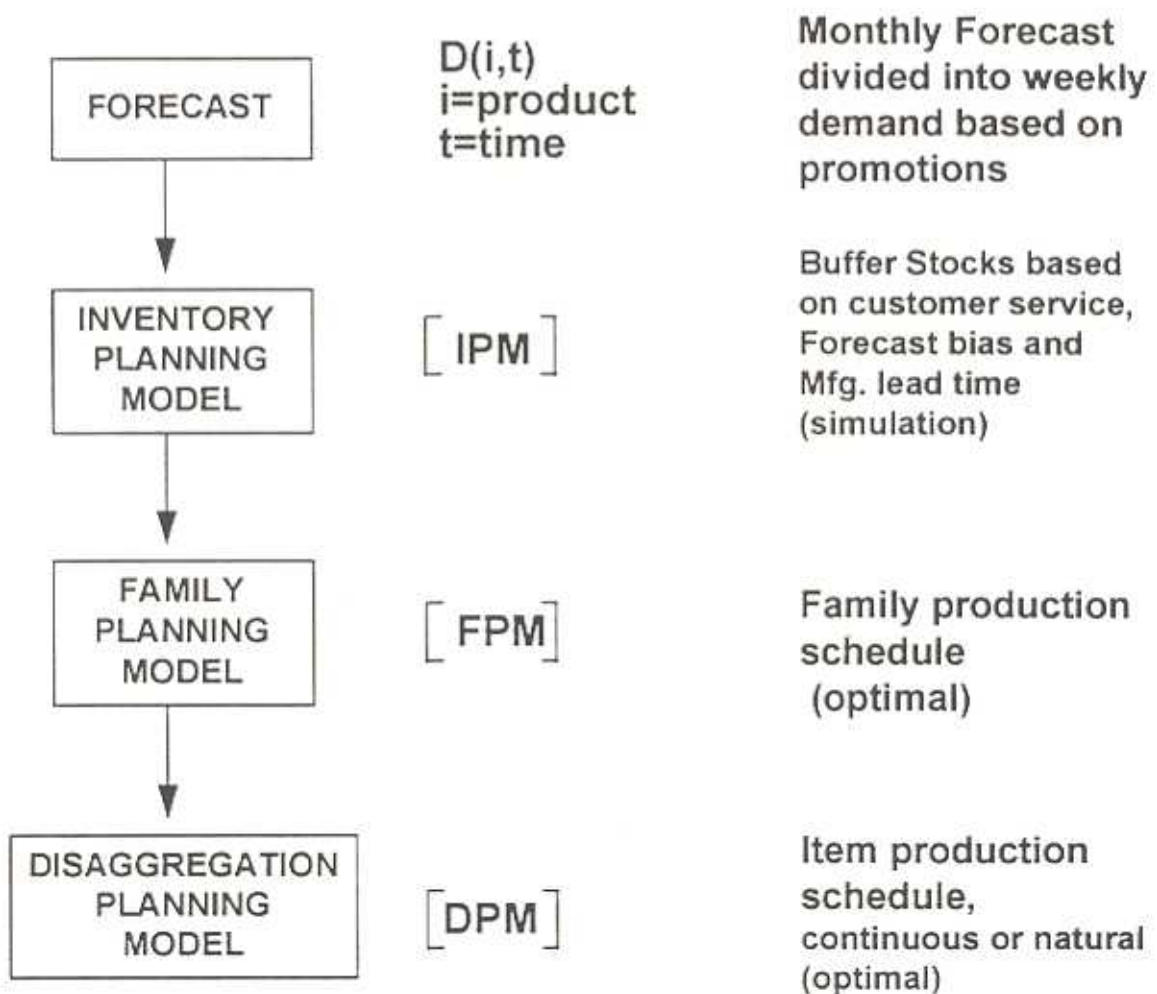
- Forecast errors
- Forecast bias
- Customer service requirements
- Dynamic nature of demand

REFINEMENTS DESIRED

1. Smooth peak future demand periods so that production capacity is not exceeded.
2. Provide a means of lot sizing which balances major (family) set-up and holding costs.
3. Retains and utilizes the safety stock capabilities of the existing IPM system.
 - Customer Service
 - Forecast error + bias
 - Product Hold time

SYSTEM OVERVIEW

Figure 1



FAMILY PLANNING MODEL (FPM)

Planning Horizon

Next 4 weeks by week

Subsequent 5 months by month

Functions

Meet demand subject to production limits

Maintain safety stocks provided by IPM

Balance set-up and holding costs over the next 4 week period by week.

DISAGGREGATION PLANNING MODEL (DPM)

Horizon - next 4 weeks by week

Functions

Meet family production requirements provided by FPM

Provide lot sizes for individual products

- Number of cases/run
- Number of quarter shifts per run

Lot sizes balance set-up and holding costs

APPLICATION

Line 4 (NE) Characteristics

14 end items

4 families:

Family 1: 502, 512) 2 lb.

Family 2: 505, 515) 18 oz.

Family 3: 507, 517, 557) TB

Family 4: 508, 590-595) T.F.

Aggregated (Family) Data - See Table 1

TABLE 1: Family Data										Time Available-hours	
Period	Demand - units				Buffers -units				Reg. Time	Overtime	
	D(1,t)	D(2,t)	D(3,t)	D(4,t)	B(1,t)	B(2,t)	B(3,t)	B(4,t)	AR(t)	AO(t)	
(Weeks) 1	52.50	4.50	9.20	8.30	65.03	13.12	21.94	11.53	80	36	
2	32.73	6.48	10.14	13.63	68.61	12.98	23.17	13.27	80	36	
3	32.73	6.48	10.14	13.63	70.50	14.17	26.00	18.57	80	36	
4	32.73	6.48	10.14	13.63	70.88	14.17	26.56	19.80	80	36	
(Months) 5	48.63	42.30	38.94	44.65	29.16	15.39	38.16	14.76	320	144	
6	44.26	72.74	31.22	44.78	29.16	15.39	38.16	14.76	320	144	
I(i,0)	60.00	6.00	20.00	25.00	units,	Beginning inventories					
CH(i)	150.00	150.00	150.00	150.00	\$/unit/week,	Holding costs					
CO(i)	172.00	124.00	212.00	121.00	\$/unit,	Overtime costs					
r(i)	.92	.67	1.14	.65	hours/unit	Time required per unit of production					
CS(i)	400.00	400.00	400.00	400.00	\$/set-up,	Set-up costs					
S(i)	8.00	8.00	8.00	8.00	hours,	Set-up time					

APPLICATION (Continued)

Family Planning Model Results - See Table 2

Period	Family Production Requirement				Family Ending Inventories - units				Family Overtime Production - units			
	P(1,t)	P(2,t)	P(3,t)	P(4,t)	I(1,t)	I(2,t)	I(3,t)	I(4,t)	O(1,t)	O(2,t)	O(3,t)	O(4,t)
(Weeks) 1	57.53	17.96	11.14	0	65.03	19.46	21.94	16.70	0	32.33	0	0
2	36.31	0	14.00	10.20	68.61	12.98	25.80	13.27	0	0	0	0
3	34.62	14.15	10.36	18.93	70.50	20.65	26.00	18.57	0	26.00	0	0
4	33.11	0	10.70	14.86	70.88	14.17	26.56	19.80	0	0	0	0
(Months) 5	6.91	43.52	50.54	39.61	29.16	15.39	38.16	14.76	0	0	0	0
6	44.26	72.74	31.22	44.78	29.16	15.39	38.16	14.76	0	0	0	0

APPLICATION (Continued)

Disaggregation of Family 3

Product Data - See Table 3

Results - See Table 4

Period	Demand - units			Buffers - units		
	D(1,t)	D(2,t)	D(3,t)	B(1,t)	B(2,t)	B(3,t)
(Weeks) 1	6.70	0.50	2.00	17.99	0.93	3.02
2	6.78	1.48	1.88	19.03	0.98	3.16
3	6.78	1.48	1.88	17.12	3.16	5.72
4	6.78	1.48	1.88	16.73	3.60	6.23
I(i,0)	12.89	2.66	4.45	units, Beginning inventories		
CH(i)	150.00	150.00	150.00	\$/unit/week, Holding costs		
CS(i)	100.00	100.00	100.00	\$/set-up, Set-up Costs		
S(i)	0.50	0.50	0.50	hours, set-up time		
p(i)	1.81	1.65	1.78	units/¼ shift, productivities		

Holding and Set-up Costs Included: Cost = \$18,057.00											
Period	# of ¼ shift lots			Ending Inventories			Production Requirements			Planned Production	Aggregate Requirements*
	Z(1,t)	Z(2,t)	Z(3,t)	I(1,t)	I(2,t)	I(3,t)	P(1,t)	P(2,t)	P(3,t)		
(Weeks) 1	7	0	1	18.86	2.16	4.23	12.67	0	1.78	14.45	11.14
2	4	1	3	19.32	2.33	7.69	7.24	1.65	5.34	14.23	14.00
3	3	3	0	17.97	5.80	5.81	5.43	4.95	0	10.38	10.36
4	3	0	3	16.62	4.32	9.27	5.43	0	5.34	10.70	10.70
Holding and Set-Up Costs Excluded: Cost = \$18,122.50											
Period	# of ¼ Shift lots			Ending Inventories			Production Requirements			Planned Production	Aggregate Requirements*
	Z(1,t)	Z(2,t)	Z(3,t)	I(1,t)	I(2,t)	I(3,t)	P(1,t)	P(2,t)	P(3,t)		
(Weeks) 1	7	0	1	18.86	2.16	4.23	12.67	0	1.78	14.45	11.14
2	4	3	1	19.32	5.63	4.13	7.24	4.95	1.78	13.97	14.00
3	4	0	2	19.78	4.15	5.81	7.24	0	3.56	10.80	10.36
4	2	2	2	16.62	5.97	7.49	3.62	3.30	3.56	10.48	10.70

* Aggregate production requirements for family 3 from FPM (see Table 2, P(3,t)).

CONCLUSIONS

This proposed system: IPM+FPM+DPM accounts for

- 1. Forecast errors and bias**
- 2. Customer service level requirements**
- 3. Production capacity limits and promotional demand peaks**
- 4. Family set-up and holding costs**
- 5. Individual product set-up and holding costs.**
- 6. Continuous or integer lot sizes**

OPERATIONAL CONSIDERATIONS

Run model once per week

Interactive capability can be designed

Computer time required: total of 5 minutes per
line

Software required: WHAT'S BEST (LINDO in a
spreadsheet environment

- Excel spreadsheet will not handle integer variables in Linear Programming models. WHAT'S BEST does.