AN EXPERIMENT IN INVENTORY CONTROL

by

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ABSTRACT

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The Problem

An experiment to determine whether exponential smoothing with seasonal adjustments, i.e., sales trend adjustments, and economic manufacturing quantity calculations will provide the necessary tools for inventory control at Central Foundry Company.

The Procedure

Exponential smoothing was used to forecast sales for a future period of time based on recent past information. By using the sales quantity of an item from the immediate past period as a present starting base a future period sales was forecast. A seasonal adjustment was made to the future forecast by the percent of sales experienced in the past years for that period of time.

The economic manufacturing quantity was determined by using an established EOQ formula that considered the annual rate of sales for the item, the setup cost for that item in the department, the inventory carring cost of the item, and the unit or standard cost of the item.

Together these calculations provided the scheduling department the tools of predicting future requirements and the economical scheduling of the department to meet these requirements.

Conclusions

The objectives of the investigation were realized:

(1) Inventories were reduced through use of this planning tool.

(2) The customer service level increased resulting in fewer out-of-stock conditions.

(3) A balanced inventory was obtained.

(4) The inventory turns per annum were increased from four to eight.

(5) Sales forecasts were within 14% variance of actual shipments rather than the previous 33%.

August 1972

AN EXPERIMENT IN INVENTORY CONTROL

A Thesis

Presented to

the Faculty of the Graduate School

Appalachian State University

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts

by

JOHNNY G. FLOYD

August 1972

ACKNOWLEDGMENT

Sincere appreciation is expressed to the management of Central Foundry Company for affording the opportunity to combine this research paper with an on-going and important project in the company for inventory control. This combination provides the unique avenue to put into practice this piece of work in a real-life industrial situation.

Also, appreciation goes to the faculty of the School of Business at Appalachian State University for their motivation and participation in this project.

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CHAPTER 1

INTRODUCTION

At Central Foundry Company a problem of finished goods inventory balance existed. While there was ample inventory, in terms of dollars and quantity, it was not in the correct items. In the past Central Foundry's production planning and control function had to guess, assume, or otherwise estimate what items were going to sell in the future. The need for improved production planning and sales forecasting techniques were obvious.

The production planning function was assigned the responsibility for planning the future needs for manufacturing the product. The demand or sales forecast provided by the marketing organization was the vital element in this preparation. As sales rates change at the consumer level, production rates must also change. When sales rates increase, well-controlled inventory levels must generally increase also to maintain the same level of customer service. The opposite effect caused production to drop drastically when sales fell off even moderately. Control over such fluctuations was established to ease the impact of unemployment and other economic ills of depression/boom cycles.

First order exponential smoothing with seasonal adjustment was used for forecasting the expected sales, and economic manufacturing quantities were calculated to provide economical and smooth operation of the production facilities.

THE PROBLEM

An experiment to determine whether exponential smoothing with seasonal adjustments, i.e., sales trend adjustments, and economic manufacturing quantity calculations will provide the necessary tools for inventory control at Central Foundry Company.

Statement of the Problem

Can inventories by properly forecast and economically planned for the disamatic department of Central Foundry Company?

Analysis

Will exponential smoothing and economic order quantity calculations provide the necessary tools for accurately forecasting sales and planning production?

Delimitations

The production plan and forecasted sales requires evaluation by the production planner in loading the disametic department, i.e., if the department is loaded to a point greater than production capacity fewer items

than forecasted must be scheduled. If external requirements affect the rate of sale of an item the production planner must make allowances for these fluctuations in scheduling the department. The forecasted production plan, for the best results, required judgments altering it to some degree by the production planner at the time the schedule was finalized. The production plan was simply a guide or planning tool used in assisting production in loading the manufacturing department.

THEORETICAL FRAMEWORK

Several conditions are sought in this investigation:

(1) Inventories must be reduced through proper use of this planning tool.

(2) The customer service level must be increased resulting in fewer out-of-stock conditions.

(3) A balanced inventory must also be attained, i.e., few items that do not sell readily and an adequate supply of those items with high sales rates.

(4) The number of inventory turns per annum must be increased to at least eight.

(5) The forecasted sales must be within 33% variance of actual sales to improve on past forecast error.

Definitions

Exponential smoothing.--"Weighted Average" method

for updating forecasts regularly.[1]

Economic order quantities.--That quantity which best balances the costs related to the number of orders placed against the costs related to the size of the orders placed.[2]

Computerized forecast.--Use of data processing equipment for providing a routine method for updating and making forecast.

Production plan.--The theoretical plan for the best cost-performance ratio for scheduling production.

Disamatic.--A diesel operated device that automatically makes cast iron fittings with automatic raw material feed operators.

Basic Assumptions

(1) Central Foundry's business is seasonal and followed generally the building industry cycle behavior.

(2) The disamatic department could be scheduled.

(3) An acceptable forecast can be made for future periods by substituting each of the eight forecasted sales for the oldest value of the rate-of-sale when determining a new average for use in the forecasting formula.

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[1]R. G. Brown, Statistical Forecasting for Inventory Control (New York: McGraw, 1959).

[2]W. Evert Welch, Tested Scientific Inventory Control (Greenwich, Conn.: Management Publishing Company, 1956).

CHAPTER 2

THE FORECASTING AND PRODUCTION PLANNING PROCEDURE

Several considerations were given the forecasting and planning procedure by use of exponential smoothing and economic manufacturing quantity calculations. First, exponential smoothing was a means of forecasting sales for a future period of time based on recent past information. For example, by using the quantity of an item sold last week substituted as a present starting base a future period sales was forecast by use of the exponential smoothing formula. Second, a seasonal adjustment was made to a future forecast by the percent of sales experienced in the past years for that period of time. For instance, if the forecast was for a fast selling period of time the quantity was adjusted upward based on the percent of historical sales for the period. Finally, the economic manufacturing quantity was determined by using an established EOQ formula that considers the annual rate of sales for the item, the setup cost for that item in the department, the inventory carrying cost of the item, and the unit or standard cost of the item.

By using the average rate-of-sale for the past seven week period and the most recent week's sales a forecast was made by using the exponential formula. The EMQ formula was employed by using the average of the past seven weeks sales multiplied times fifty-two weeks for the annual sales.

First Order Smoothing

General formula:

New forecast = α x sales + (1 - α) x old forecast[1]

Reduced form:

New forecast = old forecast + α (sales - old forecast)

The new forecast was factored against the trend table of historical sales to determine the seasonal adjustment. Table 1 represents the trend of shipments for Central Foundry beginning with the first week of July as a percent of a year of shipping.

(alpha) is the term for the weighting factor.

$\alpha = 2/(n+1) = 2/(7+1) = .25$; n is the number of weeks for moving average.

New forecast = forecast for next period.

Old forecast = forecast from previous period; using past 7 weeks average.

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[1]Leonard J. Garrett and Melton Silver, Production Management Analysis (New York: Harcourt, Brace and World, Inc., 1966), pp. 288-300.

Sales = actual sales; actual or new forecast for present period was used.

Using the forecasted sales volume the economic manufacturing quantity was determined by the following equation[2]

$$EMQ = EOQ = \sqrt{\frac{2US}{IC}}$$

U = Annual usage, pieces.
S = Ordering or setup cost, dollars.
I = Inventory carrying cost, decimal fraction per dollar of average inventory per annum.
C = Unit cost, dollar per piece.

Together these calculations provided the scheduling department the tools of predicting future requirements and the economical scheduling of the department to meet these requirements.

The degree of success of these calculations will be measured against the conditions required as outlined in the Theoretical Framework. Also, the forecasted sales should show a good correlation to actual sales; no more than fifteen percent variance is expected between products over the eight weeks forecasted.

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[2]Thomas R. Prince, Information Systems for Management Planning and Control (Homewood, Ill.: Irwin, Inc., 1966), p. 144.

TABLE 1

SHIPMENTS BY % WEEKLY

Week	%	Week	%
1	2.32%	27	----
2	1.35	28	1.98%
3	2.26	29	1.96
4	2.00	30	2.11
5	2.06	31	2.21
6	2.34	32	2.26
7	2.05	33	1.51
8	1.57	34	1.43
9	1.89	35	2.13
10	1.80	36	1.32
11	1.02	37	1.86
12	2.13	38	1.61
13	2.09	39	1.83
14	2.44	40	1.98
15	2.48	41	1.71
16	2.50	42	2.21
17	2.18	43	2.50
18	2.29	44	2.29
19	1.86	45	2.50
20	2.00	46	2.37
21	1.81	47	2.31
22	1.09	48	2.21
23	1.69	49	1.86
24	1.76	50	2.26
25	1.50	51	1.97
26	1.02	52	2.28

(Average shipment per week 1.96)

Note: Week 1 is the beginning of the fiscal year July and week 52 is year end in June. Week 27 represents the Christmas holiday shut-down.

CHAPTER 3

ANALYSIS OF THE DATA

The first forecast and economic calculations for analysis were made October 17, 1971 (Table 2). The static features of this forecast were as follows:

1. The rate-of-sale or shipments for the past seven weeks were shown starting with the sixth week through the current week. The sixth week represented shipments for the week ending August 21, 1971, and the current week represented shipments for the week ending October 16, 1971.
2. The average-weekly-sales was determined by adding the seven weeks sales and dividing by seven.
3. The stock or inventory position was shown for each item.
4. The weeks-supply was determined by dividing the average-weekly-sales into stock.
5. The economic-manufacturing-quantity was calculated by using the equation on page 7.
6. The year-to-date sales were displayed reflecting total sales activity.

TABLE 2

DISAMATIC SALES FORECAST AND PRODUCTION PLAN DATE 10/17/71

PS-ITEM NO. DESCRIPTION	6TH	5TH	4TH	3RD	2ND	1ST	CURR.	AVG WK SL	STOCK	WEEKS SUPLY	MIN. STOCK	MAX. STOCK	Y.T.D. SALES
	RATE OF SALES BY WEEKS												
32-1-100003 4 1/4 BD	1035	1959	1656	1016	2171	721	1011	1374	35857	26			19873
WEEKS	1ST	2ND	3RD	4TH	5TH	6TH	7TH	8TH					
SALES FORECAST	1639	1728	1794	1513	1576	1372	850	1103					
PRODUCTION REQUIREMENTS											EMQ		
32-1-103001 2 1/8 BD	2703	1442	3327	3765	2030	2250	2197	2510	5276	2	7500	22500	39215
WEEKS	1ST	2ND	3RD	4TH	5TH	6TH	7TH	8TH					
SALES FORECAST	3102	2996	2846	2942	2986	2714	1646	2260					
PRODUCTION REQUIREMENTS		991	3446	2942	2986	2714	1646	2260			EMQ	21500	
32-1-103002 3 1/8 BD	980	643	936	1811	1330	909	1916	1166	2950	3	4000	12000	18348
WEEKS	1ST	2ND	3RD	4TH	5TH	6TH	7TH	8TH					
SALES FORECAST	1629	1244	1704	1529	1533	1330	865	1157					
PRODUCTION REQUIREMENTS		223	1704	1529	1533	1330	865	1157			EMQ	10000	
32-1-103003 4 1/8 BD	2700	2559	2886	3146	3302	1856	2030	2700	40948	15	1800	5400	40320
WEEKS	1ST	2ND	3RD	4TH	5TH	6TH	7TH	8TH					
SALES FORECAST	3296	3331	3541	3047	3067	2742	1683	2324					
PRODUCTION REQUIREMENTS											EMQ		
32-1-104003 4 1/16 BD	833	904	513	1485	705	1227	1249	976	32472	33	2100	6300	12876
WEEKS	1ST	2ND	3RD	4TH	5TH	6TH	7TH	8TH					
SALES FORECAST	1357	1228	1380	1265	1273	1205	726	900					
PRODUCTION REQUIREMENTS											EMQ		
32-1-151003 4X4 SAN TEE	850	1237	1913	796	1366	875	1265	1253	12944	11			18186
WEEKS	1ST	2ND	3RD	4TH	5TH	6TH	7TH	8TH					
SALES FORECAST	1536	1572	1674	1302	1440	1324	819	1110					
PRODUCTION REQUIREMENTS											EMQ		
32-1-152003 4X3 Y	713	147	500	514	508	444	400	470	1003	4	1750	5200	7812
WEEKS	1ST	2ND	3RD	4TH	5TH	6TH	7TH	8TH					
SALES FORECAST	530	500	630	502	535	510	300	412					
PRODUCTION REQUIREMENTS				457	565	510	300	412			EMQ	04300	
32-1-152003 4X4 Y	1056	723	2777	2405	861	509	1150	1364	24351	18	3000	10500	16356
WEEKS	1ST	2ND	3RD	4TH	5TH	6TH	7TH	8TH					
SALES FORECAST	1708	1738	1957	1584	1472	1350	860	1200					
PRODUCTION REQUIREMENTS											EMQ		
42-3-100003 4 1/4 BD	540	576	553	941	1110	1123	961	531	38564	39	2000	6000	12340
WEEKS	1ST	2ND	3RD	4TH	5TH	6TH	7TH	8TH					
SALES FORECAST	1218	1210	1317	1161	1206	1105	662	894					
PRODUCTION REQUIREMENTS											EMQ		

TABLE 2 (continued)

DISAMATIC DATE 10/17/71

FG-ITEM NO.	DESCRIPTION	MAN PLT	DIST WHPS	6TH	5TH	4TH	3RD	2ND	1ST	CURR.	AVG WK SL	STOCK	WEEKS SUPLY	MIN. STOCK	MAX. STOCK	Y.T.D. SALES
				RATE OF SALES BY WEEKS												
42-3-103001	2 1/8 BD			876	893	1593	556	2387	1481	892	1211	5954	5	4000	12000	14673
	WEEKS	1ST	2ND	3RD	4TH	5TH	6TH	7TH	8TH							
	SALES FORECAST	1472	1033	1727	1489	1610	1400	821	1134							
PRODUCTION REQUIREMENTS					207	1610	1400	821	1134					EMQ	10000	
42-3-103002	3 1/8 BD			1104	1243	935	569	552	964	1387	972	1314	1	6000	15000	15522
	WEEKS	1ST	2ND	3RD	4TH	5TH	6TH	7TH	8TH							
	SALES FORECAST	1299	1203	1231	1100	1172	1134	698	917							
PRODUCTION REQUIREMENTS		84	1203	1231	1100	1172	1134	698	917					EMQ	08500	
42-3-104003	4 1/16 BD			640	876	322	243	153	214	239	385	14092	37	1250	3750	5389
	WEEKS	1ST	2ND	3RD	4TH	5TH	6TH	7TH	8TH							
	SALES FORECAST	459	427	395	324	331	312	199	277							
PRODUCTION REQUIREMENTS														EMQ		
42-3-152003	3X3 Y			353	511	697	457	154	386	230	397	441	1	1500	3300	5440
	WEEKS	1ST	2ND	3RD	4TH	5TH	6TH	7TH	8TH							
	SALES FORECAST	453	486	512	413	405	387	233	326							
PRODUCTION REQUIREMENTS		22	486	512	413	405	387	233	326					EMQ	03600	
50-0-111002	2 1/8 BEND			1514	2911	2199	1859	1230	3025	2500	2150	42130	20	5000	16800	31231
	WEEKS	1ST	2ND	3RD	4TH	5TH	6TH	7TH	8TH							
	SALES FORECAST	2546	2872	2975	2565	2696	2003	1502	2068							
PRODUCTION REQUIREMENTS														EMQ		
50-0-111004	4 1/8 BEND			1361	866	870	457	1965	3187	1768	1542	23097	15	5300	8900	19819
	WEEKS	1ST	2ND	3RD	4TH	5TH	6TH	7TH	8TH							
	SALES FORECAST	2077	1978	2179	1978	2201	2016	1166	1510							
PRODUCTION REQUIREMENTS														EMQ		
50-0-214003	4X4 CY 2 1/2 BEND			773	408	695	746	2130	539	806	275	6983	8	1750	5250	9743
	WEEKS	1ST	2ND	3RD	4TH	5TH	6TH	7TH	8TH							
	SALES FORECAST	1115	1111	1243	1121	1191	992	607	834							
PRODUCTION REQUIREMENTS								338	834					EMQ		
50-0-420002	2 P TRAP			980	964	650	950	924	631	799	843	18270	22	1750	5250	9590
	WEEKS	1ST	2ND	3RD	4TH	5TH	6TH	7TH	8TH							
	SALES FORECAST	1082	1045	1092	960	977	869	547	746							
PRODUCTION REQUIREMENTS														EMQ		
50-0-432002	2X1-1/2 TAPPED P TRA			505	257	587	656	858	614	1221	700	13499	19	1350	4050	8557
	WEEKS	1ST	2ND	3RD	4TH	5TH	6TH	7TH	8TH							
	SALES FORECAST	1079	979	1086	976	1036	903	535	756							
PRODUCTION REQUIREMENTS														EMQ		

7. The sales forecast was made for a period of eight weeks. The first week represented expected shipments for the week ending October 23, 1971, and the eighth week represented expected shipment for the week ending December 11, 1971.
8. The production requirements represented the requirement for production as the forecasted sales reduced stock.

In using the production planning report the production planner scanned the weeks available column. When an item was reflected that had four weeks or less inventory available based on the average weekly sales an economic manufacturing quantity was calculated. The following example explains the procedure.

For example: 32-1-103001 2-1/8" bend

a. Safety stock for all items was four weeks supply.
b. Weeks supply = stock/average weekly sales.
c. The inventory carrying cost was calculated at 15% or $0.15 per dollar of inventory per annum.
d. The unit cost was calculated at 25% of the list price.

e. The set-up cost was calculated as shown in Appendix 1.

f. $EMQ = EOQ = \sqrt{\frac{2US}{IC}}$[1]

$$U = \frac{n + 1 \text{ --- } n + 7}{n} = 2510 \times 52 = 130{,}520 \text{ pieces}$$

$S = \$108.00$

$I = \$0.15$

$C = \$1.60 \times 25\% = .40$

$$EMQ = \sqrt{\frac{2(130{,}520)108}{.15(.40)}} = 21{,}500 \text{ units}$$

Therefore, the economic manufacturing quantity for the 2-1/8" bend for an average rate of sale of 2510 was 21,500 units or 8.57 weeks supply. The production planner scheduled this item for immediate production because of a safety stock condition or weeks supply of only two weeks as shown in Table 2.

The production planner used the historical rate-of-sale, average-weekly-sales, stock, YTD sales, and sales forecast for intuitive and judgmental decisions that sometimes altered the quantity scheduled from the EMQ. A plant shut-down for a number of weeks required a judgmental decision altering the EMQ. If the

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[1]Reference page 7.

sales forecast shows a sharp decline or rise from the average rate-of-sale, a judgmental decision may be required of the production planner to alter the EMQ.

Each week the forecast was made anew and weeks supply determined based on the most recent information concerning sales and stock. A new average-weekly-sales was calculated each week by moving the most recent week's shipment into the current position of the "rate-of-sale" and shifting the other weeks' supply over by one with the oldest week's shipments being removed.

The sales forecast and production requirement was recalculated each week taking advantage of changing trends and the most recent information on shipments. An eight-week forecast was made each week for the eight shipping periods in the future. This forecast for each period was deducted from stock to show the minimum production requirement for each period if the EMQ could not be met, and this forecast was a guide for production planning and sales personnel.

An example of the forecast method follows.

For example: 32-103001 2-1/8" bend

New forecast = old forecast + α (sales - old forecast)[2]

a. Old forecast = average weekly sales = 2510

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[2]Reference page 6.

b. $\alpha = .25$

c. Sales = current sales = 2197

New forecast = 2510 + .25(2197 - 2510) = 2432.

By applying seasonal adjustment, the week number of Table 1 was 16 corresponding to the week of October 23 for the first period forecast.[3] The percent of sales was 2.50 and the average equals 1.96%. Therefore,

New forecast = 2432(2.50)/1.96 = 3102 units.

The next seven weeks were forecast the same as above by taking a new average based on the previous forecast and substituting this new average for the "old forecast" and substituting the previous forecast for "sales" in the equation. The seasonal adjustment used the next period for each forecast on Table 1.

Table 3 is the production planning chart and is a summary of items to be produced. The chart was developed by scanning Table 2 and listing those items requiring production. The chart served as working papers for the department.

The production planning chart describes the item, and provides a column for weeks supply and the EMQ. A completion date column was provided to designate the date the item-quantity was to be completed. This chart

---

[3]Reference page 6 and Table 1.

TABLE 3

PRODUCTION PLANNING CHART
OCTOBER 17, 1971

Item No.	Desc.	Wk's Supply	Qty. Sch. - Compl. Date			
		EMQ	10/23	10/30	11/6	11/13
32-1-103001	2-1/8 Bd	2/21,500	21,500			
32-1-103002	3-1/8 Bd	3/10,000		10,000		
32-1-152005	4 x 3 Y	4/4,300			4,300	
42-3-103002	3-1/8 Bd	1/8,500	8,500			
42-3-152003	3 x 3 Y	1/3,600	3,600			

was distributed to the department foremen as production orders.

Each week this exercise was repeated and the production planner made any necessary adjustments in the previous schedule not completed and scheduled additional items as required. A safety stock of four weeks was considered ample and items were scheduled for production that fell below this level.

Table 4 shows the comparison of forecasted to actual shipments. As depicted, the results are very good. The variance from actual ranges from 0 to 14% which was close enough for planning purposes, particularly when a new forecast and planning analysis was made each week. The variance was calculated by summing the forecasted and actual sales for each item for the eight periods (ignore both values when the actual sales has an asterisk) and subtracting the difference and dividing by the sum of the forecasted sales.

The forecasting and planning techniques provided the desired results in inventory turns as shown in Figure 1. In October of 1971 the Company was experiencing four inventory turns per annum based on current month calculations. For instance, the inventory value at the end of October, 1971 was $6,075,636 and the cost-of-sales for the twelve-month period was $24,417,086. If the inventory valuation for October was

TABLE 4

FORECASTED SALES VS. ACTUAL SHIPMENTS
OCTOBER 17, 1971

Item No.	Description		Week Ending								
			1st 23 Oct.	2nd 30 Oct.	3rd 6 Nov.	4th 13 Nov.	5th 20 Nov.	6th 27 Nov.	7th 4 Dec.	8th 11 Dec.	% Variance
32-1-100003	4-1/4 Bd	F	1669	1728	1794	1513	1576	1372	850	1183	2
		A	1793	2005	1526	1374	1222	1221	1105	436*	
32-1-103001	2-1/8 Bd	F	3102	2996	3446	2942	2986	2714	1648	2260	14
		A	1647*	2202	2933	2529	2285	1283*	1904	2114	
32-1-103002	3-1/8 Bd	F	1629	1544	1704	1529	1533	1398	865	1157	10
		A	1463	1476	1537	1227	1118	1265	1050	1038	
32-1-103003	4-1/8 Bd	F	3296	3331	3541	3047	3067	2742	1683	2334	5
		A	3421	3310	3254	3729	2354	2391	2152*	1898	
32-1-104003	4-1/6 Bd	F	1357	1288	1389	1265	1273	1206	726	966	7
		A	1296	1159	1291	1016	1148	1103	700	1053	
32-1-151006	4 x 4 San Tee	F	1590	1572	1674	1382	1446	1324	819	1110	2
		A	1411	1227	1545	1595	1645	1444	1004	841	
32-1-152005	4 x 3 Y	F	599	569	639	553	565	510	309	423	4
		A	566	475	766	701	540	487	452	352	
32-1-152006	4 x 4 Y	F	1706	1738	1957	1584	1472	1366	868	1205	9
		A	1623	1284	1761	1344	1258	1151	998	1371	
42-3-100003	4-1/4 Bd	F	1219	1218	1317	1161	1206	1105	660	894	11
		A	1196	1066	1128	1148	980	895	1425*	814	

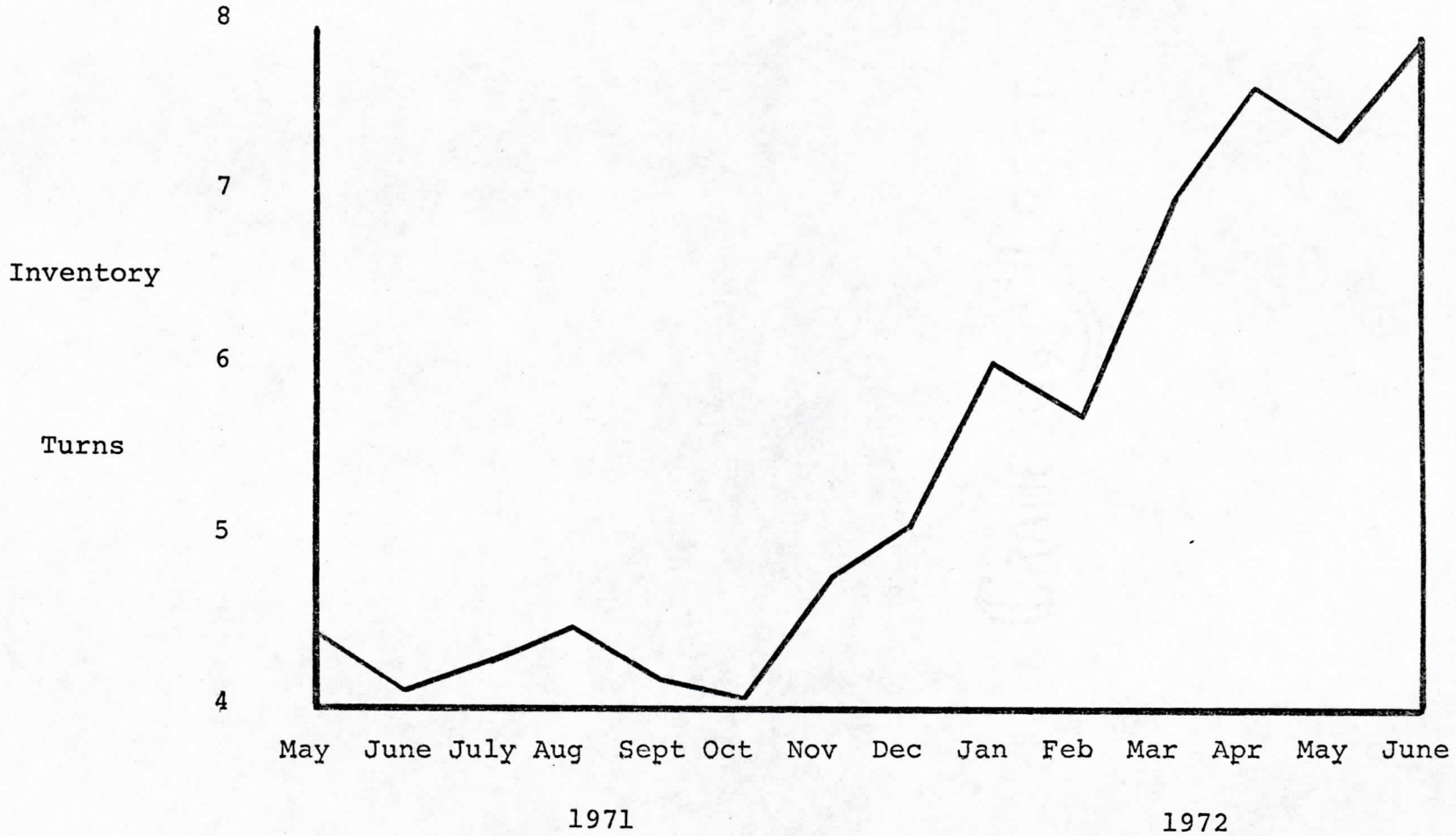
TABLE 4 (Continued)

Item No.	Description		Week Ending 1st 23 Oct.	2nd 30 Oct.	3rd 6 Nov.	4th 13 Nov.	5th 20 Nov.	6th 27 Nov.	7th 4 Dec.	8th 11 Dec.	% Variance
42-3-103001	2-1/8 Bd	F	1472	1533	1727	1489	1610	1400	821	1134	13
		A	1143	1376	1051*	1101	1411	1026	909	1294	
42-3-103002	3-1/8 Bd	F	1399	1263	1281	1100	1172	1134	698	917	6
		A	1345	1465	1163	1042	1706	228*	1640*	873	
42-3-104003	4-1/16 Bd	F	454	437	395	324	331	318	199	277	2
			399	340	185*	478	409	296	156	212	
42-3-152003	3 x 3 Y	F	463	486	512	413	405	387	233	326	1
			497	393	463	393	357	432	258	388	
58-0-111002	2-1/8 Bd	F	2946	2872	2975	2565	2696	2603	1552	2068	6
		A	3350	2783	7471*	2259	2050	2469	1466	1831	
58-0-111004	4-1/8 Bd	F	2077	1978	2179	1978	2201	2056	1166	1550	0
		A	2431	3669*	2316	2304	1751	2127	1044	1248	
58-0-214008	4 x 4 CY	F	1115	1111	1243	1121	1191	993	607	834	0
	& 1/8 Bd	A	983	888	1637	1238	1344	87*	526	1435*	
58-0-420002	2 P Trap	F	1082	1045	1092	960	977	889	547	746	1
		A	972	846	1247	853	1221	772	682	634	
58-0-422002	2 x 1-1/2	F	1079	979	1086	976	1036	963	588	766	5
	Tapped P	A	893	890	1204	1188	887	741	629	669	
	Trap										

*Item shipped to other warehouses which cannot be planned and holiday weeks which are not planned. Asterisk columns were excluded from variance calculations.

FIGURE 1

INVENTORY TURNS PER ANNUM

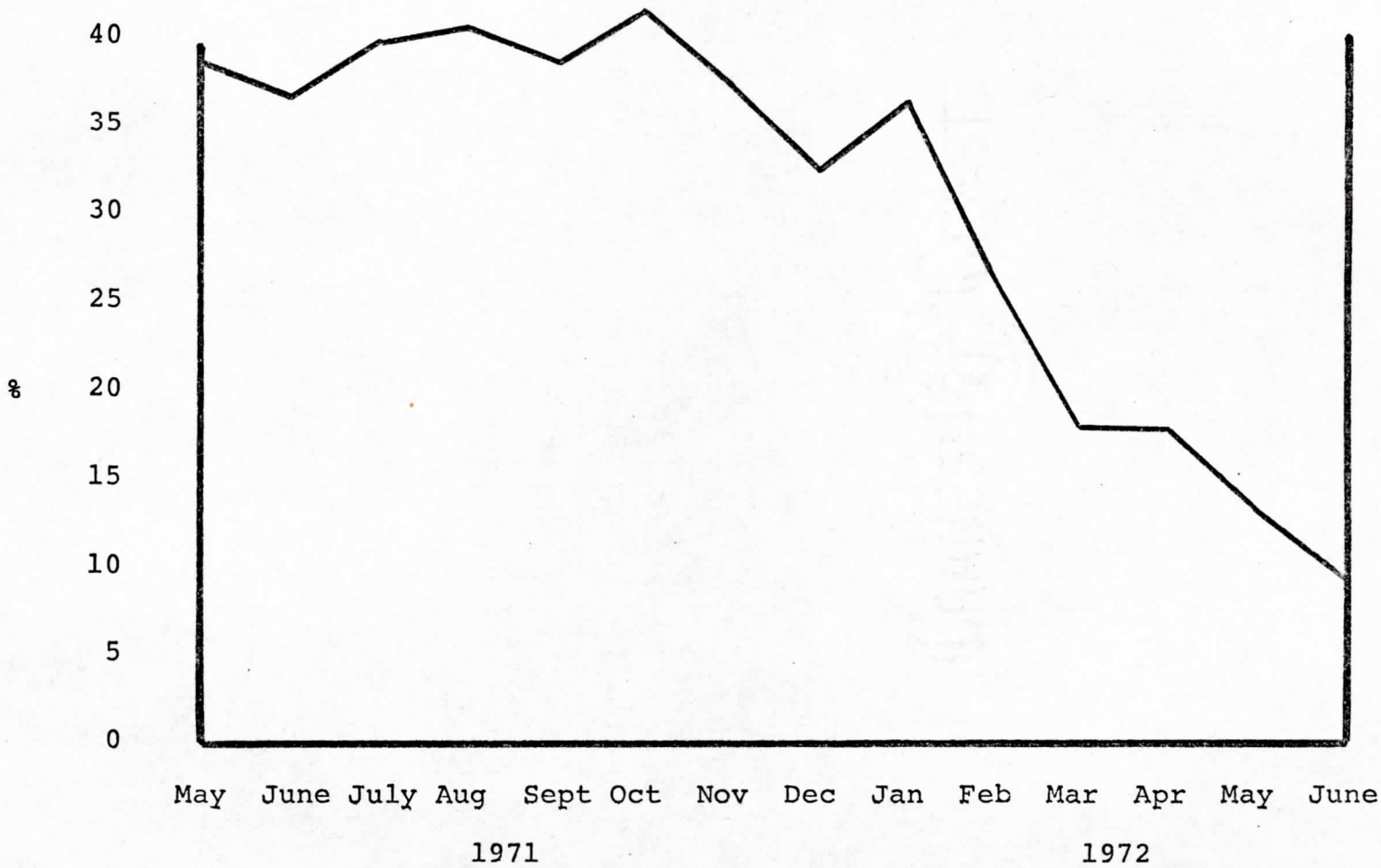


divided into the cost-of-sales for the twelve-month period the inventory turns are approximately four. By using this planning tool the Company decreased inventory while increasing sales. The inventory value at the end of June was $3,765,114 and the cost-of-sales for the twelve-month period ending in June was $29,981,677 resulting in an inventory turn of approximately eight.

Figure 2 shows the improvement in short shipments resulting from the use of this planning tool. In October, 1971, the Company experienced one shipment in two that was shipped short to the customer. For the month of October total truck shipments were 457 and 193 of these were short at least one item. Percentage of shortages was calculated to be 42% by dividing 193 by 457. The month of June, 1972, the Company shipped 489 truck loads of material to customers of which 45 were short at least one item. During June shortages had dropped to 9% of the total. The inverse of Figure 2, of course, is the customer service level.

FIGURE 2

SHORT SHIPMENTS AS A PERCENT OF TOTAL SHIPMENTS



CHAPTER 4

DISCUSSION

Central's most important responsibility was using the forecast intelligently. First this meant showing the forecaster the implications of his forecast on the manufacturing activity and on customer service. It meant presenting to management the effects of possible forecast errors on inventories, operating costs, and customer relations. Continuous communication was maintained between the originators and the users of the forecast to promote better understanding and insure quick response to changing conditions.

In using the forecast, production control took advantage of forecast characteristics; they separated the planning of capacity from actual scheduling within the manufacturing cycle, making a long-term commitment only to capacity and making the shortest possible commitment to the actual production schedule. This permitted taking advantage of the greater accuracy with which large product groups could be forecast, as compared to the individual items which make up the production schedule. The shorter the scheduling cycle, the better the reaction to actual

changes in sales. Weekly schedules reflected the latest information on actual demand while firm schedules far into the future were highly inaccurate because forecasts become less accurate when they are extended.

The crux of using the forecast intelligently in the production control department involved recognizing forecast characteristics and designing the production control system to take the fullest advantage of the characteristics.

CONCLUSIONS

Central Foundry Company has experienced excellent results from this inventory control tool. It is planned for implementation in all their manufacturing facilities and in each department.

Inventories have been reduced as shown in Figure 1 and the level of customer service has increased. The forecasting of sales was accurate within 0 to 14 percent as Table 4 indicated.

The objectives of the investigation were realized.

(1) Inventories were reduced through use of this planning tool.

(2) The customer service level increased resulting in fewer out-of-stock conditions.

(3) A balanced inventory was attained.

(4) The inventory turns per annum were increased to eight.

(5) Sales forecasts were within 14% variance of actual shipments.

The experiment in inventory control was very successful and more than met the expectation of Central. Although the inventory level was reduced, the safety stock level of four-weeks prevented shortages and back-orders.

The goal of Central is to improve inventory control and, simultaneously, to develop sound, flexible production control systems based on forecasting principles and characteristics.

RECOMMENDATIONS

Table 4 shows the forecast error to be 14%, however this calculation is for a limited number of items and represents items with sales history. For new products and promotional items it is recommended that the forecast error be monitored very closely for any wider variations from actual sales.

In forecasting demand for promotional items and new products the initial impact should be considered. The initial impact of high volume orders from promotions should be forecast conservatively until the full impact of consumer use is determined to avoid over-reacting on the part of the forecaster.

After the forecasting method has been implemented in all departments of the Company, it is recommended that

the average of the forecasted sales to determine weeks supply be used rather than the historical rate-of-sale.

When the forecast has been implemented it should be tracked by measuring actual sales against the forecasted movement. Central Foundry has a very good record of forecast error as shown in Table 4.

The set-up cost and inventory carrying cost should be calculated as accurately as possible to insure an accurate calculation of the economic manufacturing quantity. Central's set-up cost for the disamatic department is shown in the Appendix.

CHAPTER 5

SUMMARY

These basic forecasting responsibilities were developed at Central to maximum effectiveness of the forecasting functions:

1. Make the forecast - - - - Marketing working with Production control
2. Use the forecast to plan production - - - - - Production control
3. Track the forecast - - - Production control
4. Report deviations from forecast - - - - - - Production control
5. Interpret deviations and revise the forecast - - - Marketing
6. Revise production plans to reflect the revised forecast - - - - - - - - Production control.

The inventory control procedure did work for Central. Inventories were properly forecast and economic manufacturing quantities were calculated. Exponential smoothing did provide the tool for forecasting the requirement of production to meet the sales forecast. The

disamatic department was scheduled very accurately with 0 to 14 percent effectiveness, certainly good enough for planning and scheduling inventory levels.

Central was able to evaluate the sales pattern and respond to the change forecasted. Also, the forecast was easily compared to the production capability by planning the economies involved in the sales projection.

The sales and marketing departments were too busy selling and developing new promotional efforts to be concerned with regularly updating forecast parameters for the many items involved. The solution was for marketing to provide forecasts in meaningful manufacturing terms, but only for groups of finished products, together with forecasts for special items where past history would not be a reliable guide for future activity. The production control department made routine forecasts for run-of-the-mill items that constituted the bulk of the typical inventory investment.

A four-week safety stock was maintained, preventing stock-outs and shortages, without adversely affecting the inventory level.

Production control advised marketing of the groups of products important in planning the level of operation and of the terms meaningful in the manufacturing activities. Production control also provided data on past demand history and forecast errors which served to provide a

base for marketing in preparing a new forecast. Production control insisted on a measure of forecast error, not forcing marketing to admit their forecasts were poor, but simply to get realistic estimates on which to base constructive action. The most important contribution to improved forecasting is close cooperation between the marketing and production control departments.

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APPENDIX

DISAMATIC COST FACTORS INVOLVED IN CHANGING A PATTERN
OCTOBER 4, 1971

1. 1 mechanic and 1 helper will change a pattern in 10 minutes.

1 @ 3.92 x 10/60 =	.65	
1 @ 3.20 x 10/60 =	.43	
		$1.08

2. 5 production people (Disamatic) will be idle while pattern is being changed.

(1) Operator	3.44	
(2) Bull Runner	2.71	
(3) Iron Pourer	2.66	
(4) Core Hauler	2.61	
(5) Relief Man	2.56	
		2.33

3. To change 3 core boxes, one (1) head changer and one (1) helper require 1-1/2 hours per box.

1 @ 3.44 x 1-1/2 =	5.16	
1 @ 2.81 x 1-1/2 =	4.22	
	9.38 x 3 =	28.14

4. During the time the pattern is being changed on the Disamatic, 50 molds are lost.

   5 molds/min. x 10 min. = 50 molds

   These molds have, on the average, 20# of castings per mold.

   20 x 50 = 1000 pounds, or 1/2 ton @ 77.00/ton = 38.50
   (Profit 36.00 + OH 41.00 = 77.00)

5. While core boxes are being changed, 3 core machines are idle for 1-1/2 hours. They would produce during this time

$$\frac{400 \text{ blows}/8 \text{ hrs.}}{8 \text{ hrs.}} \times 1\text{-}1/2 \text{ hrs.} \times 2 \text{ cores/blow} = 150 \text{ cores}$$

which are worth, on the average, 150 x .25 = 37.50

$107.55