

Using "Fabricated" History to Plan Inventory in a Volatile Distribution Environment

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Introduction

Like most companies, Oscar Mayer has a forecasting system which is never quite good enough to please everybody. Recent changes to the company's physical distribution system have made forecasting an even greater challenge. After we could no longer improve the statistical algorithms used to forecast, attention focused on developing tools to evaluate forecasts in the proper historical context. What this paper describes is not so much a forecasting system, but a system to review and override the forecasts that have been generated.

Business Environment

Oscar Mayer Foods is the nation's largest producer of processed meats. Product is distributed nationwide through a network of 11 refrigerated distribution centers (DC's). Each DC has an assigned base of customers which it services, and for which it receives a weekly forecast.

Due to the perishable nature of our product, the desire to maintain a high level of customer service carries a great deal of risk. Simply put, if we carry too much inventory it may go "overage" before it can be sold. This makes inventory planning a balancing act -- having enough inventory to fill orders, while not so much as to go overage.

Forecasting at the DC/Item level has been made more difficult by volatility in the physical distribution system. In recent years several DC's have been closed, and new ones have been opened. Each change entails a shift in the assignment of customers to DC's. The result is that a DC's literal shipment history is not necessarily representative of future demand at that DC. The DC's current customer base may have little resemblance to its customer base of a year ago (or even a week ago). More than likely, customers have been added from a closed DC, and customers lost to a new DC. Evaluating forecasts with respect to a DC's literal shipment history becomes worthless -- you are not comparing apples to apples.

The forecast evaluation problem was solved by development of a SAS/AF* application which generates "fabricated" shipment history. By merging customer-to-DC assignments with demand history at the customer level, we can fabricate history for a DC based on a specified customer base. This lets local inventory planners evaluate forecasts in the proper historical context. We devote the remainder of this paper to the specific workings of the system.

Data Files

Generation of fabricated history requires raw historical data at the customer level, and a file of customer-to-DC assignments. Our history files go back to 1987, and contain roughly four million records per year. These files update each week through batch jobs. Records are keyed by customer number (SAS* variables ROUTE and ACCOUNT), item number (ITEM), week ending date (WEDATE), and the DC which shipped the product (PLANT). We also keep the amount of product ordered (ORDER) and filled (FILL).

The assignment file is maintained on a SAS/FSP* screen by our Corporate Distribution department. The screen (shown below) is keyed by customer number. It contains other information about the customer (name, city, state, sales center, when they last ordered product, and their relative size) which makes the file easier to maintain. Most important, the file designates the DC's from which the customer should be shipped.

INVOICED: 07/14/91		0000 SALES PLANNING SYSTEM 0100 0000 CUSTOMER PLANT ASSIGNMENTS 0100		PF3=EXIT PF8=FORM PF5=FIND PF7=BACK	
CUSTOMER *****	ROUTE: 4015 ACCOUNT: 166	NAME: US NAVY COMMISSARY CITY: PHILADELPHIA STATE: PA	1 CORPORATE BUSINESS: 0.00457 2 CENTER BUSINESS: 0.33288		
CENTER: 450 CP PHILADEL					
SHIP FROM DC *****	NEW: NORMAL:	413 NEWCASTLE 413 NEWCASTLE (ITEMS MADE BY ON)	413 NEWCASTLE 413 NEWCASTLE (ITEMS MADE BY LR)	413 NEWCASTLE 293 NEWBERRY (LR CHILL PACK)	
REASSIGNMENT IN EFFECT *****	FROM W.E.: 08/04/91 (BLANK=IMMEDIATELY) THRU W.E.: (BLANK=INDEFINITELY) IS REASSIGNMENT PERMANENT? Y (V)		NOTE: AT LEAST ONE DATE MUST BE ENTERED FOR REASSIGNMENT TO TAKE EFFECT.		
<pre> ***** *** THE "NEW" SHIP FROM DC IS USED WHEN A REASSIGNMENT IS IN EFFECT -- OTHERWISE, THE "NORMAL" SHIP FROM DC IS USED *** ***** </pre>					

Because most DC's do not handle the full product line, a customer might be assigned to different DC's according to the category of product. We have three categories: Oscar Mayer (red meats), Louis Rich (processed turkey), and Louis Rich Chill Pack (fresh, unprocessed turkey parts). By item number we identify the proper category, and thereby assign the appropriate DC.

For each category of product there is a "NORMAL" DC and a "NEW" DC. Normal is, of course, where the customer normally pulls its product. The new DC is used in conjunction with the "FROM," "THRU," and "PERM" fields to indicate an upcoming reassignment.

We are able to time-phase assignment changes by identifying a "new" DC and putting the effective date in the FROM field. If this reassignment is permanent, we indicate with a "Y" in the PERM field. If only a temporary reassignment, we can specify a THRU date after which the assignment goes back to the NORMAL DC. We can also leave THRU blank for an indefinite temporary reassignment.

Maintaining Customer Assignments

Maintaining the accuracy of customer assignments is extremely important. Since assignments are also used in the forecasting system, each assignment error results in demand attributed to the wrong DC.

Weekly batch jobs monitor the assignment file and perform several maintenance functions. For example, when a permanent reassignment takes effect the old NORMAL DC is replaced by the NEW DC. Another very important maintenance function is the detection of assignment violations.

Violations are detected by comparing each customer's assigned DC with the DC from which they actually pulled product. Some violations have a reasonable explanation and can be ignored (e.g., a truckload quantity shipping straight from the manufacturing facility rather than through the DC). Other times, violations indicate an error in the assignment file that must be corrected.

 *** VIOLATIONS OF OSCAR MAYER PLANT ASSIGNMENT ***

1:32 MONDAY, JULY 15, 1991

ROUTE	ACCT	NAME	CITY	STATE	CENTER	ASSIGNED ON PLANT	INVOICED SHIP PLT	ON ITEM TONNAGE
1664	215	ECONOMY WHOLESALE CO INC	LA VALE	MD	144 CP CLEVELAND	057 JOLIET	413 NEWCASTLE	239
1664	216	ECONOMY WHOLESALE CO INC	LA VALE	MD	144 CP CLEVELAND	057 JOLIET	413 NEWCASTLE	516
1694	203	CLEVECO FOODS INC	LA VALE	MD	144 CP CLEVELAND	057 JOLIET	413 NEWCASTLE	361
1736	950	WEGMANS FOOD MARKETS INC	ROCHESTER	NY	148 CP SYRACUSE	413 NEWCASTLE	200 DAVENPORT	39,228
1736	950	WEGMANS FOOD MARKETS INC	ROCHESTER	NY	148 CP SYRACUSE	413 NEWCASTLE	413 NEWCASTLE	5,442
2253	320	F & A FOOD SALES INC	CONCORDIA	KS	234 CP KANSAS CT	200 DAVENPORT	600 SHERMAN	458
2253	320	F & A FOOD SALES INC	CONCORDIA	KS	234 CP KANSAS CT	200 DAVENPORT	200 DAVENPORT	361
3160	239	DOMINICKS FINER FOODS INC	NORTMLAKE	IL	340 CP CHICAGO	057 JOLIET	017 WOODSTOCK	24,888
3303	949	WEAVER POULTRY CO INC	TOLEDO	OH	345 CP DETROIT	057 JOLIET	019 MOMENCE	4,050
3303	949	WEAVER POULTRY CO INC	TOLEDO	OH	345 CP DETROIT	057 JOLIET	057 JOLIET	2,570
4038	55	GIANT FOOD STORES INC	CARLISLE	PA	450 CP PHILADEL	413 NEWCASTLE	017 WOODSTOCK	
4046	5	ACME MARKETS INC	PHILADELPHIA	PA	450 CP PHILADEL	413 NEWCASTLE		
4100	43	BJ'S WHOLESALE CLUB INC	FAIRFIELD	CT	451 CP BOSTON	047		
4138	103	HANNAFORD BROS CO	SCHODACK LAMON	NY	451 CP BOSTON			
4202	330	A ROGGERO FOOD PROD INC	UNION CITY					
4311	61	PACE MEMBERSHIP WHSE #61						
4312	702	PRICE CO INC						
4312	702	PRICE CO INC						

Fabricated History Reports

We have created several versions of fabricated history reports. Some of these run in weekly batch jobs, while others are submitted on request. The most useful report has been the "10 Week Forward/Backward History," which can be requested by a corporate or DC planner through their SAS/AF menus. This is the only report we will discuss.

The "10 Week ..." report shows the last ten weeks of history, along with the next ten weeks from one year ago. (Thus, if we are currently in week 31, the report would show weeks 21-30 of this year, along with weeks 31-40 of last year.) This time frame is usually enough to judge forecasts and target inventory levels over the next several weeks.

Below is the screen where planners enter their request. The DC is specified, and the planner selects either actual or fabricated history. Actual history is what literally shipped from the DC. Fabricated history is what literally shipped to those customers assigned to the DC on the given date -- no matter what DC actually shipped the product. In the example, we are requesting fabricated history based on assignments of 07/21/91. We are also requesting the past ten weeks, and the next ten weeks (from a year ago), and to have the report expressed in pounds.

0000 SALES PLANNING SYSTEM 0000
 0000 TEN WEEK DC HISTORY 0000

PF9=ADD REQUEST PF8=FORWARD
 PF3=EXIT PF7=BACKWARD

DC: 413 NEWCASTLE (Enter 3-digit plant code)

SHOW ACTUAL SHIPMENTS - OR - "FABRICATED" HISTORY BASED ON CUSTOMER ASSIGNMENTS OF W.E. 07/21/91 (MM/DD/YY)

(Leave blank for actual DC shipment history)

(If you want "fabricated" history, enter the Sunday W.E. date for the current week or a future week.)

(If you asked for "fabricated" history, print list of the assigned customer base: N (Y/N))

SHOW LAST 10 WEEKS OF SHIPMENTS: Y (Y/N)

SHOW NEXT 10 WEEKS OF SHIPMENTS: Y (Y/N) (Next ten weeks from one year ago)

SHOW SHIPMENTS IN BOXES OR LBS: L (B/L) (Default is LBS)

 INSTRUCTIONS: Hit (PF9) to add a request. Hit (PF3) to exit and submit the report job.

Specify the DC whose history you wish to see.

If you want a "fabricated" history based on the DC's assigned customers, specify the week whose assignments you want to use. This must be the Sunday W.E. date of the current week or any future week. You CANNOT ask for assignments of a past week because the system does not save that information.)

Specify whether you want history for the last 10 weeks and/or history for the next 10 weeks from one year ago.

Indicate whether you want the report expressed in BOXES or LBS.

For comparison, we show two versions of the report, one with the fabricated history requested above, and another using actual history. As you can see, the two versions are quite different. This is because Newcastle is a new DC which has undergone several assignment changes over the last few months. In particular, note that there is no actual history for last year because the facility did not exist.

SHIPMENTS FROM: 413 NEWCASTLE											
**** FABRICATED USING C7/21/91 ASSIGNMENTS ****											
REPORT UNIT: LBS											
ITEMS	10 WK AVG	05/12/91	05/19/91	05/26/91	06/02/91	06/09/91	06/16/91	06/23/91	06/30/91	07/07/91	07/14/91
DC TOTAL	3,584,191	3,722,332	4,016,136	3,683,077	3,103,291	3,331,065	4,255,528	4,468,228	5,794,389	1,541,544	2,473,449
1	75,888	75,332	118,236	74,016	41,992	22,938	119,186	173,472	105,588	5,332	21,216
2	24	24	64	64	104	56	80	68	24	92	80
3	1,336	2,332	1,248	2,088	284	1,332	648	756	1,432	4,332	24
4	112	128	120	228	216	172	108	136	328	72	32
5	276	276	276	276	276	276	276	276	276	276	276
6	2,776	3,282	2,356	1,784	3,102	2,388	3,414	2,004	3,876	1,864	3,188
7	179,128	198,772	258,882	174,288	124,488	225,528	94,248	270,216	322,176	44,688	82,456
8	2,882	2,882	2,882	2,882	2,882	2,882	2,882	2,882	2,882	2,882	2,882
9	49,268	52,440	50,344	58,872	48,184	41,580	36,884	57,480	68,056	15,732	33,632
10	124	360	360	482	122	120	120	204	144	96	318
11	83,732	56,412	293,760	68,628	35,788	14,412	118,188	130,280	93,472	-	-
12	173,548	152,760	217,728	168,936	91,272	82,896	277,392	120,280	-	-	-
13	59,476	44,508	93,492	57,488	58,008	77,074	-	-	-	-	-
14	240	-	600	600	-	-	-	-	-	-	-
15	71,112	87,712	-	-	-	-	-	-	-	-	-

SHIPMENTS FROM: 413 NEWCASTLE											
**** FABRICATED USING C7/21/91 ASSIGNMENTS ****											
REPORT UNIT: LBS											
ITEMS	10 WK AVG	07/15/90	07/22/90	07/29/90	08/05/90	08/12/90	08/19/90	08/26/90	09/02/90	09/09/90	09/16/90
DC TOTAL	3,584,191	3,122,723	3,522,513	3,493,966	3,573,966	3,204,994	3,682,584	4,132,521	3,775,013	3,335,915	3,947,577
1	31,468	23,768	33,700	47,086	27,712	20,700	28,344	55,596	28,920	18,352	23,732
2	6,132	20,376	1,728	6,122	3,672	3,336	6,744	1,752	6,120	9,448	5,352
3	132	1,176	588	162	84	136	136	44	260	128	136
4	162	1,120	220	232	148	204	212	1,032	732	1,188	1,008
5	1,476	228	1,440	1,824	1,944	1,440	2,964	1,332	1,320	1,144	1,128
6	133,788	103,848	244,032	118,488	133,136	44,432	44,432	1,180	1,624	3,776	3,442
7	3,956	1,596	4,968	1,848	3,648	70,888	84,408	218,376	172,896	71,888	83,712
8	40,972	31,936	25,572	26,988	51,180	45,960	47,040	65,688	49,688	30,920	35,488
9	29,248	21,360	19,192	24,072	9,456	4,500	210	120	340	180	236
10	98,848	58,132	139,200	77,688	34,488	44,748	31,184	55,188	22,448	24,036	27,220
11	2,442	50,904	35,712	41,604	38,336	35,076	31,180	1,812	130,248	44,448	-
12	44,368	936	288	2,472	2,160	2,376	1,44	82,874	-	-	-
13	1,456	-	-	-	-	-	-	-	-	-	-
14	4,100	4,080	4,072	3,912	-	-	-	-	-	-	-
15	28,804	28,252	28,252	-	-	-	-	-	-	-	-

SHIPMENTS FROM: 413 NEWCASTLE											
**** FABRICATED USING C7/21/91 ASSIGNMENTS ****											
REPORT UNIT: LBS											
ITEMS	10 WK AVG	05/12/91	05/19/91	05/26/91	06/02/91	06/09/91	06/16/91	06/23/91	06/30/91	07/07/91	07/14/91
DC TOTAL	2,546,982	1,449,523	1,513,938	2,205,018	1,548,405	2,437,238	3,307,064	3,736,399	5,084,106	1,485,644	2,331,552
1	44,912	13,056	13,360	26,352	28,700	17,424	82,896	135,168	105,600	5,332	21,216
2	72	64	64	64	92	56	80	68	24	92	80
3	648	240	492	1,344	884	600	648	756	1,432	4,332	24
4	142	60	204	204	208	172	108	136	328	72	32
5	276	276	276	276	276	276	276	276	276	276	276
6	2,424	1,204	2,424	1,204	2,424	1,32	204	288	300	228	348
7	144,932	139,968	120,744	147,284	94,272	133,248	94,248	270,216	322,176	44,688	82,456
8	2,512	156	576	1,096	3,192	2,584	2,016	4,156	4,156	912	336
9	39,746	21,396	29,836	41,544	36,612	34,512	36,884	59,160	92,028	15,732	33,632
10	276	72	180	180	120	120	300	294	294	96	378
11	39,716	4,224	21,996	34,188	23,952	12,832	43,936	122,356	99,984	5,332	-
12	129,832	62,624	81,264	143,424	33,322	64,588	160,872	122,356	290,544	11,664	-
13	41,612	22,236	22,212	31,488	30,848	39,252	65,040	78,668	91,672	-	-
14	57,288	54,400	34,524	44,616	40,472	70,344	-	-	-	-	-
15	44,912	436	3,348	362	-	-	-	-	-	-	-
16	152	72	180	180	-	-	-	-	-	-	-
17	42,536	1,144	1A,272	122	-	-	-	-	-	-	-

Technical Considerations

The merging and summarizing of large history and assignment files utilizes considerable computer resources. Whenever possible, you should subset the files before merging, to extract only the needed records. After merging, you may be able to delete additional records prior to summarizing customer level data to the assigned DC level. For ad hoc reporting, you can often extract only those customers and items of interest, thereby saving much processing time.

Conclusion

We have discussed the difficulties of forecasting and inventory planning in a volatile distribution environment. Whenever a distribution center's customer base is changed, the DC's literal shipment history becomes worthless, because it no longer reflects the DC's current customer base. We have shown how "fabricated" history can help solve this problem.

A SAS system was developed to maintain history and assignment files, to merge these files by customer, and to summarize the results according to assigned DC. This process generates the "fabricated" (as opposed to "actual") history which can be valuable to the forecaster and inventory planner.

Trademark Notice

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