



*Practical Issues to Consider When
Selecting a Forecasting Process*

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Brinmar Consulting Associates



Overview

- ❖ Our discussion will relate to forecasting systems for finished goods inventory in a distribution system
- ❖ We are not referring to forecasting systems to:
 - Determine capacity requirements and rates of production for production planning
 - Support an MRP system
 - Establish sales budgets and quotas



Background Issues

- ❖ How much effort does your forecasting system require?
 - Does your forecasting system involve a substantial amount of user input?

OR

- Is little time spent with your forecasting system because no one fully understands the impact of parameter changes (i.e. it's a "black box")?



Background Issues (cont'd)

- ❖ Does system complexity match demand patterns?
 - Are you forecasting a seasonality component for a product line with no known cause for seasonal demand? (or the reverse)
 - Are you using trend factors for product lines where demand trends are not an issue? (or the reverse)



Background Issues (cont'd)

- ❖ How accurate and timely are your end item forecasts?
 - Is the inaccuracy of your forecasting system causing:
 - ◆ Unnecessary costs for investment in excess inventory?
 - ◆ Lost profits from missed sales opportunities caused by stock-outs?
 - Does system provide *timely* estimates of changes in demand patterns?



Background Issues (cont'd)

- ❖ Are your forecasting efforts focused on the factors that will yield high service levels?

Is demand variability a more significant issue than the level of demand

- ❖ Have you tested alternate forecasting methods?
- ❖ Are you testing the effectiveness of your forecasting system on an on-going basis?



Forecast Interval

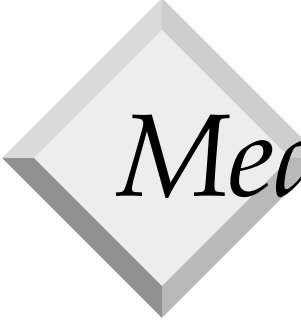
- ❖ Frequently Used Options
 - Weekly
 - Monthly
- ❖ Considerations
 - Workload
 - ◆ Weekly - 52 iterations per year
 - ◆ Monthly - 12 iterations per year
 - ◆ A weekly forecast requires more than 4 times as much effort as a monthly



Forecast Interval (cont'd)

❖ Considerations (cont'd)

- Timeliness of demand change recognition (opportunity to change plans)
 - ◆ If it takes three or four months to build enough history to trip a tracking signal, is it too late for a timely response?
- Lead times (ability to change plans)
 - ◆ If supplier lead times are 4 - 6 months, how much value is there to having a system that responds in weeks?



Measuring Demand Variability

- ❖ Test demand variability (Mean Absolute Deviation “MAD” or Standard Deviation “s”)
 - Calculate MAD or s as a *ratio* to average
 - “Typical” relationships - MAD = .15 - .25 and s = .20 - .30
- ❖ Is demand variability exceptionally high? (ref. Tile 1-4)
 - Focus on demand variability measures

Example - High Demand Variability Items

	<u>Tile 1</u>	<u>Tile 2</u>	<u>Tile 3</u>	<u>Tile 4</u>
Mth 1	298	3,231	47	1
Mth 2	0	980	2,373	1,284
Mth 3	171	1	1,730	1,908
Mth 4	24	120	486	813
Mth 5	0	30	3,231	1,256
Mth 6	648	95	670	0
Mth 7	141	3,874	2,233	910
Mth 8	198	444	3,124	3,250
Mth 9	100	294	1,087	302
Mth 10	66	900	3,486	690
Mth 11	19	158	2,770	1,973
Mth 12	272	420	354	123
Mth 13	193	664	11,767	75
Mth 14	42	394	1,136	306
Mth 15	5	180	444	9,678
Mth 16	0	1,261	780	1,488
Mth 17	58	168	112	21,362
Mth 18	83	232	1,655	3,046

	<u>Tile 1</u>	<u>Tile 2</u>	<u>Tile 3</u>	<u>Tile 4</u>
Mth 19	34	308	530	9,142
Mth 20	159	0	588	21,155
Mth 21	0	1,242	1,272	5,126
Mth 22	78	188	800	14,862
Mth 23	91	12	150	2,145
Mth 24	<u>200</u>	<u>142</u>	<u>3,354</u>	<u>7,254</u>
Total	2880	15,338	44,179	108,149
Avg	120	639	1,841	4,506
MAD	100	640	1,468	4,753
MAD/Avg	0.83	1.00	0.80	1.05
s (std dev)	140	956	2,343	6,235
s/Avg	1.17	1.50	1.27	1.38
MAD/s	0.71	0.67	0.63	0.76
s/MAD	1.40	1.49	1.60	1.31



Measuring Demand Variability (cont'd)

- ❖ Is demand variability exceptionally low? (ref. Tile 5 & 6)

Focus on demand rate estimates including trends and seasonality

- ❖ Is demand variability “typical”? (ref. JS 1-4)

Focus on both demand variability and rate

Example - Low Demand Variability Items

	Tile 5	Tile 6
Mth 1	203,946	137,465
Mth 2	158,355	158,261
Mth 3	180,142	150,866
Mth 4	187,144	132,425
Mth 5	180,846	124,494
Mth 6	199,764	122,323
Mth 7	156,935	138,884
Mth 8	143,261	134,774
Mth 9	136,882	142,168
Mth 10	128,141	138,157
Mth 11	139,689	140,480
Mth 12	139,491	145,967
Mth 13	136,483	132,462
Mth 14	160,459	148,496
Mth 15	165,194	135,967
Mth 16	149,775	130,801
Mth 17	152,752	134,924
Mth 18	188,373	144,061

	Tile 5	Tile 6
Mth 19	182,645	138,240
Mth 20	171,364	144,047
Mth 21	167,879	137,882
Mth 22	151,402	126,907
Mth 23	174,978	138,509
Mth 24	<u>190,465</u>	<u>146,808</u>
Total	3,946,365	3,325,368
Avg	164,432	138,557
MAD	18,296	6,206
MAD/Avg	0.11	0.04
s (std dev)	21,180	8,182
s/Avg	0.13	0.06
MAD/s	0.86	0.76
s/MAD	1.16	1.32

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Example - "Typical" Demand Variability Items

	<u>PI Bags 1</u>	<u>Scrub Pad</u>	<u>Soap</u>	<u>P Towels</u>
Mth 1	125	35	257	1673
Mth 2	110	37	183	1464
Mth 3	172	48	159	1986
Mth 4	120	40	194	1925
Mth 5	134	24	218	1615
Mth 6	147	28	231	1840
Mth 7	132	34	171	2000
Mth 8	163	22	311	2078
Mth 9	141	43	178	1754
Mth 10	130	25	221	2240
Mth 11	163	23	288	2000
Mth 12	140	32	299	1844
Mth 13	106	24	276	2342
Mth 14	140	28	283	2005
Mth 15	171	37	241	2383
Mth 16	145	30	220	1709
Mth 17	183	27	201	1788
Mth 18	127	41	211	2269

	<u>PI Bags 1</u>	<u>Scrub Pad</u>	<u>Soap</u>	<u>P Towels</u>
Mth 19	130	24	253	2,169
Mth 20	155	28	248	1,815
Mth 21	180	34	209	2,055
Mth 22	182	30	309	1,639
Mth 23	142	24	282	2,099
Mth 24	<u>167</u>	<u>21</u>	<u>180</u>	<u>2,212</u>
Total	3,505	739	5,623	46,904
Avg	146	31	234	1,954
MAD	19	6	39	203
MAD/Avg	0.13	0.20	0.17	0.10
s (std dev)	22	7	45	241
s/Avg	0.15	0.23	0.19	0.12
MAD/s	0.84	0.85	0.87	0.84
s/MAD	1.18	1.18	1.15	1.19

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Seasonality

- ❖ If seasonality exists, forecast seasonality factors for each period (weeks or months)

Reminder - seasonality period forecasts are *Year to Year* - - consider this when selecting a smoothing constant

.5 = 3 periods

.1 = 19 periods

.3 = 5 periods

.05 = 39 periods

.2 = 9 periods

periods in this situation equal years



Seasonality (cont'd)

- ❖ Use seasonality factors to deseasonalize actual demand before updating estimate of deseasonalized demand
- ❖ Rule of Thumb - forecasts involving seasonality factors should only be used if it is *obvious that a pattern of seasonality exists* and there is an *identifiable reason* for the seasonality



Seasonality (cont'd)

- ❖ Test effectiveness of using seasonality factors before implementing a process that uses them
 - Select a sample for all product lines with seasonality and determine if the use of seasonality factors significantly improves the forecast (i.e. reduces variability)
 - This is accomplished by comparing the ratio of the variability measure to average

Testing Effectiveness of Seasonality Factors (#1)

Forecasting <i>with</i>	Beginning										
	Value	WK 1	WK 2	WK 3	WK 4	WK 5	WK 6	WK 7	WK 8	WK 9	WK 10
Seasonality Factor		0.830	0.862	0.970	0.875	0.905	1.011	0.893	0.991	0.909	1.026
Seasonalized Fcst		338,419	347,483	390,715	340,795	362,287	408,604	355,135	395,846	365,239	425,535
Actual Sales		300,063	344,776	261,520	435,622	397,050	343,188	370,787	419,261	482,933	262,178
Deseasonalized Sales		361,522	399,972	269,608	497,854	438,729	339,454	415,215	423,069	531,279	255,534
Actual Seas Factor		0.887	0.992	0.669	1.278	1.096	0.840	1.044	1.059	1.322	0.616
New Seas Factor		0.847	0.901	0.880	0.996	0.962	0.960	0.938	1.011	1.033	0.903
Current Deviation		-46,212	-3,141	-133,190	108,374	38,412	-64,704	17,527	23,628	129,476	-159,217
Deseas MAD Fcst	35184	36,287	32,972	42,994	49,532	48,420	50,048	46,796	44,480	52,979	63,603
Deseas Sales Fcst	407734	403,113	402,799	389,480	400,317	404,158	397,688	399,441	401,803	414,751	398,829
MAD Fcst / Sales Fcst		0.090	0.082	0.110	0.124	0.120	0.126	0.117	0.111	0.128	0.159
Forecasting <i>without</i>	Beginning										
Seasonality Factors	Value	WK 1	WK 2	WK 3	WK 4	WK 5	WK 6	WK 7	WK 8	WK 9	WK 10
Actual Sales		300,063	344,776	261,520	435,622	397,050	343,188	370,787	419,261	482,933	262,178
Current Deviation		-38,356	10,193	-74,083	107,428	58,113	-1,560	26,195	72,049	128,516	-105,090
MAD Fcst	35184	35,501	32,970	37,082	44,116	45,516	41,120	39,628	42,870	51,435	56,800
Sales Fcst	338419	334,583	335,603	328,194	338,937	344,748	344,592	347,212	354,417	367,268	356,759
MAD Fcst / Sales Fcst		0.106	0.098	0.113	0.130	0.132	0.119	0.114	0.121	0.140	0.159

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Testing Effectiveness of Seasonality Factors (#2)

Forecasting <i>with</i>											
Seasonality Factors	<u>WK 11</u>	<u>WK 12</u>	<u>WK 13</u>	<u>WK 14</u>	<u>WK 15</u>	<u>WK 16</u>	<u>WK 17</u>	<u>WK 18</u>	<u>WK 19</u>	<u>WK 20</u>	<u>WK 21</u>
Seasonality Factor	0.993	1.057	1.032	0.999	1.052	1.040	1.178	0.903	1.022	1.045	0.922
Seasonalized Fcst	396,037	426,924	412,698	404,463	420,194	413,654	479,644	368,643	421,633	424,854	375,462
Actual Sales	446,409	384,633	463,958	350,081	402,519	511,660	492,304	407598	360334	431819	456721
Deseasonalized Sales	449,556	363,891	449,572	350,431	382,623	491,981	417,915	451,382	352,577	413,224	495,359
Actual Seas Factor	1.127	0.901	1.124	0.866	0.958	1.237	1.026	1.106	0.855	1.016	1.216
New Seas Factor	1.033	1.010	1.060	0.959	1.024	1.099	1.133	0.964	0.972	1.036	1.010
Current Deviation	50,727	-40,011	49,671	-54,437	-16,802	94,237	10,747	43,140	-59,979	6,665	88,134
Deseas MAD Fcst	62,315	60,085	59,043	58,583	54,405	58,388	53,624	52,575	53,316	48,651	52,599
Deseas Sales Fcst	403,902	399,901	404,868	399,424	397,744	407,168	408,243	412,556	406,559	407,225	416,038
MAD Fcst / Sales Fcst	0.154	0.150	0.146	0.147	0.137	0.143	0.131	0.127	0.131	0.119	0.126
Forecasting <i>without</i>											
Seasonality Factors	<u>WK 11</u>	<u>WK 12</u>	<u>WK 13</u>	<u>WK 14</u>	<u>WK 15</u>	<u>WK 16</u>	<u>WK 17</u>	<u>WK 18</u>	<u>WK 19</u>	<u>WK 20</u>	<u>WK 21</u>
Actual Sales	446,409	384,633	463,958	350,081	402,519	511,660	492,304	407598	360334	431819	456721
Current Deviation	89,650	18,909	96,343	-27,168	27,986	134,329	101,540	6,680	-41,252	34,358	55,824
MAD Fcst	60,085	55,967	60,005	56,721	53,848	61,896	65,860	59,942	58,073	55,702	55,714
Sales Fcst	365,724	367,615	377,249	374,533	377,331	390,764	400,918	401,586	397,461	400,897	406,479
MAD Fcst / Sales Fcst	0.164	0.152	0.159	0.151	0.143	0.158	0.164	0.149	0.146	0.139	0.137

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Testing Effectiveness of Seasonality Factors (#3)

Forecasting <i>with</i>											
Seasonality Factors	<u>WK 22</u>	<u>WK 23</u>	<u>WK 24</u>	<u>WK 25</u>	<u>WK 26</u>	<u>WK 27</u>	<u>WK 28</u>	<u>WK 29</u>	<u>WK 30</u>	<u>WK 31</u>	<u>WK 32</u>
Seasonality Factor	1.002	0.972	1.216	1.060	1.120	0.790	1.062	1.037	1.241	1.013	1.146
Seasonalized Fcst	416,871	416,419	510,327	443,018	464,579	333,776	459,852	442,107	526,374	421,566	483,750
Actual Sales	540882	331487	489222	409743	550803	416762	388982	419506	427134	481984	451774
Deseasonalized Sales	539,802	341,036	402,321	386,550	491,788	527,547	366,273	404,538	344,185	475,799	394,218
Actual Seas Factor	1.297	0.796	0.959	0.925	1.186	1.249	0.846	0.949	0.811	1.143	0.934
New Seas Factor	1.091	0.919	1.139	1.019	1.140	0.928	0.997	1.011	1.112	1.052	1.082
Current Deviation	123,764	-87,379	-17,356	-31,391	76,986	105,046	-66,732	-21,794	-79,967	59,643	-27,902
Deseas MAD Fcst	59,716	62,482	57,969	55,312	57,479	62,236	62,685	58,596	60,733	60,624	57,352
Deseas Sales Fcst	428,415	419,677	417,941	414,802	422,501	433,005	426,332	424,153	416,156	422,120	419,330
MAD Fcst / Sales Fcst	0.139	0.149	0.139	0.133	0.136	0.144	0.147	0.138	0.146	0.144	0.137
Forecasting <i>without</i>											
Seasonality Factors	<u>WK 22</u>	<u>WK 23</u>	<u>WK 24</u>	<u>WK 25</u>	<u>WK 26</u>	<u>WK 27</u>	<u>WK 28</u>	<u>WK 29</u>	<u>WK 30</u>	<u>WK 31</u>	<u>WK 32</u>
Actual Sales	540882	331487	489222	409743	550803	416762	388982	419506	427134	481984	451774
Current Deviation	134,403	-88,432	78,146	-9,148	132,827	-14,497	-40,827	-6,220	2,030	56,677	20,799
MAD Fcst	63,583	66,068	67,276	61,463	68,599	63,189	60,953	55,480	50,135	50,789	47,790
Sales Fcst	419,919	411,076	418,891	417,976	431,259	429,809	425,726	425,104	425,307	430,975	433,055
MAD Fcst / Sales Fcst	0.151	0.161	0.161	0.147	0.159	0.147	0.143	0.131	0.118	0.118	0.110

Testing Effectiveness of Seasonality Factors (#4)

Forecasting <i>with</i>											
Seasonality Factors	<u>WK 33</u>	<u>WK 34</u>	<u>WK 35</u>	<u>WK 36</u>	<u>WK 37</u>	<u>WK 38</u>	<u>WK 39</u>	<u>WK 40</u>	<u>WK 41</u>	<u>WK 42</u>	<u>WK 43</u>
Seasonality Factor	1.067	1.033	1.003	0.866	1.206	1.047	1.448	0.890	0.935	1.040	1.168
Seasonalized Fcst	447,425	431,520	420,403	375,056	513,717	436,992	606,009	360,092	392,132	438,478	480,600
Actual Sales	430406	446094	560264	313376	410092	448921	404492	491770	412891	333018	420259
Deseasonalized Sales	403,380	431,843	558,588	361,866	340,043	428,769	279,345	552,551	441,595	320,210	359,811
Actual Seas Factor	0.962	1.034	1.333	0.836	0.798	1.027	0.667	1.366	1.053	0.759	0.874
New Seas Factor	1.035	1.033	1.102	0.857	1.084	1.041	1.214	1.033	0.970	0.956	1.080
Current Deviation	-15,951	14,108	139,442	-71,224	-85,925	11,394	-139,169	147,953	22,202	-101,404	-51,662
Deseas MAD Fcst	53,212	49,302	58,316	59,606	62,238	57,154	65,355	73,615	68,474	71,767	69,756
Deseas Sales Fcst	417,735	419,146	433,090	425,968	417,375	418,515	404,598	419,393	421,613	411,473	406,307
MAD Fcst / Sales Fcst	0.127	0.118	0.135	0.140	0.149	0.137	0.162	0.176	0.162	0.174	0.172
Forecasting <i>without</i>											
Seasonality Factors	<u>WK 33</u>	<u>WK 34</u>	<u>WK 35</u>	<u>WK 36</u>	<u>WK 37</u>	<u>WK 38</u>	<u>WK 39</u>	<u>WK 40</u>	<u>WK 41</u>	<u>WK 42</u>	<u>WK 43</u>
Actual Sales	430406	446094	560264	313376	410092	448921	404492	491770	412891	333018	420259
Current Deviation	-2,649	13,304	126,144	-133,359	-23,307	17,853	-28,361	61,753	-23,302	-100,844	-3,519
MAD Fcst	43,276	40,279	48,865	57,314	53,914	50,308	48,113	49,477	46,859	52,258	47,384
Sales Fcst	432,790	434,120	446,735	433,399	431,068	432,853	430,017	436,193	433,862	423,778	423,426
MAD Fcst / Sales Fcst	0.100	0.093	0.109	0.132	0.125	0.116	0.112	0.113	0.108	0.123	0.112

Testing Effectiveness of Seasonality Factors (#5)

Forecasting <i>with</i>										
Seasonality Factors	<u>WK 44</u>	<u>WK 45</u>	<u>WK 46</u>	<u>WK 47</u>	<u>WK 48</u>	<u>WK 49</u>	<u>WK 50</u>	<u>WK 51</u>	<u>WK 52</u>	Avg MAD
Seasonality Factor	1.005	0.903	0.923	0.997	1.029	0.878	0.851	0.918	0.620	
Seasonalized Fcst	408,338	369,089	373,080	406,444	415,537	349,758	334,760	366,411	243,437	
Actual Sales	432759	328155	405050	368147	359274	305989	383838	306743	240528	
Deseasonalized Sales	430,606	363,405	438,841	369,255	349,149	348,507	451,043	334,143	387,948	
Actual Seas Factor	1.060	0.889	1.086	0.906	0.865	0.875	1.147	0.837	0.988	
New Seas Factor	1.021	0.899	0.972	0.970	0.980	0.877	0.940	0.894	0.730	
Current Deviation	24,299	-45,331	34,637	-38,412	-54,677	-49,851	57,670	-64,997	-4,692	
Deseas MAD Fcst	65,211	63,223	60,364	58,169	57,820	57,023	57,088	57,879	52,560	
Deseas Sales Fcst	408,737	404,203	407,667	403,826	398,358	393,373	399,140	392,640	392,171	
MAD Fcst / Sales Fcst	0.160	0.156	0.148	0.144	0.145	0.145	0.143	0.147	0.134	0.139
Forecasting <i>without</i>										
Seasonality Factors	<u>WK 44</u>	<u>WK 45</u>	<u>WK 46</u>	<u>WK 47</u>	<u>WK 48</u>	<u>WK 49</u>	<u>WK 50</u>	<u>WK 51</u>	<u>WK 52</u>	Avg MAD
Actual Sales	432759	328155	405050	368147	359274	305989	383838	306743	240528	
Current Deviation	9,333	-96,204	-9,689	-45,623	-49,934	-98,225	-10,554	-86,593	-144,149	
MAD Fcst	43,579	48,841	44,926	44,996	45,490	50,763	46,742	50,727	60,070	
Sales Fcst	424,359	414,739	413,770	409,208	404,214	394,392	393,336	384,677	370,262	
MAD Fcst / Sales Fcst	0.103	0.118	0.109	0.110	0.113	0.129	0.119	0.132	0.162	0.130



Seasonality (cont'd)

- ❖ It is frequently more appropriate and requires less effort to maintain the forecast of seasonality factors by product line instead of end items



Process Complexity

- ❖ How complex a forecasting process can your organization maintain?
 - Will a more complex process yield results whose incremental improvement has greater value than the cost of the added effort?
 - Has your staff been trained to understand and maintain a more complex process?
 - Is there sufficient time, during each forecast interval to handle the added complexity?



Intervention Required

- ❖ Estimate amount of time required for intervention using forecasting systems being considered for implementation
- ❖ Test a sample of items to identify intervention time and extrapolate to estimate time required for all SKU's
- ❖ Compare to a forecasting process that is less complex which has decision rules to “automatically” handle exceptions



Interfunctional Communication

- ❖ Does input from Sales and Marketing contribute more to forecast accuracy than complex techniques?
- ❖ Is it possible to take the simplest moving average and factor it based on Sales/Marketing input and get better results than with a purely intrinsic system that is “flying blind”?



Interfunctional Communication (cont'd)

- ❖ Is using a purely intrinsic sales forecasting process which provides no capability to input Sales/Marketing “forward look” adjustment factors similar to driving up a curvy mountain road looking backwards? (see cartoon)



Special Product Characteristics

- ❖ Short (1-2 yr) life cycles
 - No history to test for trend and seasonality
 - Ramp up and ramp down as important as forecasting demand and variability
 - Trend up and trend down may be similar to products previously in line
- ❖ Readily available substitutes
 - Consider similar products as a group
 - Focus on product with best characteristics (short L T, good margins, preferred brand)




Special Product Characteristics (cont'd)

- ❖ “Must have, no substitutes” products
 - High service objectives
 - Frequent reorder reviews
 - Responsive forecasting process
- ❖ “C” items with “lumpy” demand rates
 - Last 5% of sales
 - Often low value *or* total annual sales very few dollars compared to “A” items
 - Simple forecasting process and large reorders (3-4 mths) provides high service levels and reduces effort with minimal inventory investment

Forecasting Method Examples

- ❖ Forecasting Individual SKU's
 - Moving average most recent “X” periods
 - Simple trend-seasonal approach
 - ◆ Average last three months this year divided by average for same three months last year yields trend factor
 - ◆ Multiply trend factor times average for *next* three months *last* year accounts for seasonality
 - Exponential smoothing to forecast average and variability
 - ◆ Add trend forecast
 - ◆ Add seasonality forecast
 - ◆ Add both trend and seasonality



Forecasting Method Examples (cont'd)

- ❖ Forecast product groups and use “bill of material” approach to “explode” into end items (ref. examples of composite variability which follow)
 - Use a moving average or exponential smoothing to forecast product groups
 - Factor intrinsic forecast, from prior step, using Sales/Marketing estimate of change from base period
 - ◆ Maintain comparison of Sales/Marketing change estimate to actual
 - ◆ If Sales/Marketing change estimate is consistently optimistic or pessimistic, develop a ratio to “adjust” estimate

Composite Variability Example - High

	<u>Tile 1</u>	<u>Tile 2</u>	<u>Tile 3</u>	<u>Tile 4</u>	<u>Total</u>
Mth 1	298	3,231	47	1	3,577
Mth 2	0	980	2,373	1,284	4,637
Mth 3	171	1	1,730	1,908	3,810
Mth 4	24	120	486	813	1,443
Mth 5	0	30	3,231	1,256	4,517
Mth 6	648	95	670	0	1,413
Mth 7	141	3,874	2,233	910	7,158
Mth 8	198	444	3,124	3,250	7,016
Mth 9	100	294	1,087	302	1,783
Mth 10	66	900	3,486	690	5,142
Mth 11	19	158	2,770	1,973	4,920
Mth 12	272	420	354	123	1,169
Mth 13	193	664	11,767	75	12,699
Mth 14	42	394	1,136	306	1,878
Mth 15	5	180	444	9,678	10,307

	<u>Tile 1</u>	<u>Tile 2</u>	<u>Tile 3</u>	<u>Tile 4</u>	<u>Total</u>
Mth 16	0	1,261	780	1,488	3,529
Mth 17	58	168	112	21,362	21,700
Mth 18	83	232	1,655	3,046	5,016
Mth 19	34	308	530	9,142	10,014
Mth 20	159	0	588	21,155	21,902
Mth 21	0	1,242	1,272	5,126	7,640
Mth 22	78	188	800	14,862	15,928
Mth 23	91	12	150	2,145	2,398
Mth 24	<u>200</u>	<u>142</u>	<u>3,354</u>	<u>7,254</u>	<u>10,950</u>
Total	2880	15,338	44,179	108,149	170,546
Avg	120	639	1,841	4,506	7,106
MAD	100	640	1,468	4,753	4,529
MAD/Avg	0.83	1.00	0.80	1.05	0.64

Composite Variability Example - "Typical"


	<u>Pl Bags 1</u>	<u>Scrub Pad</u>	<u>Soap</u>	<u>P Towels</u>	<u>Total</u>
Mth 1	125	35	257	1673	2090
Mth 2	110	37	183	1464	1,794
Mth 3	172	48	159	1986	2,365
Mth 4	120	40	194	1925	2,279
Mth 5	134	24	218	1615	1,991
Mth 6	147	28	231	1840	2,246
Mth 7	132	34	171	2000	2,337
Mth 8	163	22	311	2078	2,574
Mth 9	141	43	178	1754	2,116
Mth 10	130	25	221	2240	2,616
Mth 11	163	23	288	2000	2,474
Mth 12	140	32	299	1844	2,315
Mth 13	106	24	276	2342	2,748
Mth 14	140	28	283	2005	2,456
Mth 15	171	37	241	2383	2,832

	<u>Pl Bags 1</u>	<u>Scrub Pad</u>	<u>Soap</u>	<u>P Towels</u>	<u>Total</u>
Mth 16	145	30	220	1709	2,104
Mth 17	183	27	201	1788	2,199
Mth 18	127	41	211	2269	2,648
Mth 19	130	24	253	2,169	2,576
Mth 20	155	28	248	1,815	2,246
Mth 21	180	34	209	2,055	2,478
Mth 22	182	30	309	1,639	2,160
Mth 23	142	24	282	2,099	2,547
Mth 24	<u>167</u>	<u>21</u>	<u>180</u>	<u>2,212</u>	<u>2,580</u>
Total	3,505	739	5,623	46,904	56,771
Avg	146	31	234	1,954	2,365
MAD	19	6	39	203	209
MAD/Avg	0.13	0.20	0.17	0.10	0.09

Composite Variability Example - Low

	<u>Location 1</u>	<u>Location 2</u>	<u>Location 3</u>	<u>Location 4</u>	<u>Total</u>
Mth 1	68,742	41,247	13,706	13,770	137,465
Mth 2	79,158	47,445	15,842	15,816	158,261
Mth 3	75,386	45,239	15,129	15,112	150,866
Mth 4	66,204	39,737	13,277	13,207	132,425
Mth 5	62,218	37,336	12,486	12,454	124,494
Mth 6	61,056	36,682	12,297	12,288	122,323
Mth 7	69,318	41,690	13,904	13,972	138,884
Mth 8	67,306	40,432	13,518	13,518	134,774
Mth 9	71,044	42,691	14,207	14,226	142,168
Mth 10	69,011	41,422	13,889	13,835	138,157
Mth 11	70,298	42,137	14,002	14,043	140,480
Mth 12	72,884	43,793	14,673	14,617	145,967
Mth 13	66,216	39,754	13,219	13,273	132,462
Mth 14	74,281	44,570	14,806	14,839	148,496
Mth 15	67,919	40,762	13,624	13,662	135,967

	<u>Location 1</u>	<u>Location 2</u>	<u>Location 3</u>	<u>Location 4</u>	<u>Total</u>
Mth 16	65,376	39,214	13,110	13,101	130,801
Mth 17	61,404	42,499	14,829	12,429	131,161
Mth 18	76,139	42,016	13,708	12,198	144,061
Mth 19	63,406	44,479	14,876	15,479	138,240
Mth 20	68,649	47,151	15,366	12,881	144,047
Mth 21	74,001	36,419	13,304	14,159	137,882
Mth 22	60,490	38,062	12,633	15,723	126,907
Mth 23	64,244	47,162	14,538	12,566	138,509
Mth 24	<u>76,479</u>	<u>42,100</u>	<u>15,118</u>	<u>13,110</u>	<u>146,808</u>
Total	1,651,228	1,004,040	336,060	330,277	3,321,605
Avg	68,801	41,835	14,003	13,762	138,400
MAD	4,265	2,439	780	871	6,345
MAD/Avg	0.06	0.06	0.06	0.06	0.05



Forecasting Method Examples (cont'd)

- Maintain forecast of the ratio for each SKU to the group total
- Apply ratios from preceding step to group total to generate an item forecast
- ***Caution*** - this technique provides no method to forecast demand variability *by item* to maintain safety stock

potential solution

- Periodically, calculate the ratio of MAD:Fcst for individual items using data for extended periods (min 6 mths; preferred 2 yrs)
- Use ratios from preceding step times the item's forecast to estimate MAD

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Comparing Results

- ❖ Use sample of actual demand data for a two year period
- ❖ Test forecasting processes being considered using same sets of demand data
- ❖ Use item sample that best represents the demand characteristics of product groups, *not* a random sample
- ❖ Measure forecast error as a ratio of variability (MAD or standard deviation) to average



Comparing Results (cont'd)

- ❖ This procedure can be used to compare forecasting processes or techniques, forecast intervals and the value of using trend or seasonality factors
- ❖ In addition to forecasting processes, test factors like smoothing constant or time periods for moving averages



Summary

- ❖ Our discussion has been about forecasting systems for finished goods inventory in a distribution system
- ❖ Background issues considered:
 - How much effort does your forecasting system require?
 - Does system complexity match demand patterns?

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Summary (cont'd)

- ❖ Background issues (cont'd)
 - How accurate and timely are your end item forecasts?
 - Are your forecasting efforts focused on the factors that will yield high service levels?
 - Have you tested alternate forecasting methods?
 - Are you testing the effectiveness of your forecasting system on an on-going basis?



Summary (cont'd)

❖ Forecast Interval

- Is it short enough for a timely response to changes in the demand rate?
- Is it long enough to keep work load reasonable?

❖ Measuring Demand Variability

- Is it exceptionally high or low? Consider importance of accurate measure on service objectives
- Is there an element of seasonality with an assignable cause?



Summary (cont'd)

❖ Process Complexity

- Is staff trained to understand complex process?
- Is added complexity generating improvement in results worth additional effort?

❖ Intervention Required

- Is there sufficient staff to handle level of intervention required?



Summary (cont'd)

- ❖ **Interfunctional Communication**
 - Is it possible to get improved results more a less complex process combined with Sales/Marketing input?
- ❖ **Special Product Characteristics**
 - “Must have, no substitutes” products
 - “C” items with “lumpy” demand rates



Summary (cont'd)

- ❖ Forecasting Method Examples
 - Moving average most recent “X” periods
 - Simple trend-seasonal approach
 - Exponential smoothing to forecast average and variability
 - Forecast product groups and use “bill of material” approach to “explode” into end items



Summary (cont'd)

❖ Comparing Results

- An absolute “must” at regular intervals using sample technique
- Measure forecast error as a ratio of variability to identify “significant” differences