Paper 164

Data Visualization From a Financial Services Perspective

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ABSTRACT

SAS/GRAPH® software affords ways to construct powerful data visualization tools for discovering, confirming, summarizing, and communicating patterns and relationships in a data set. This paper demonstrates the use of dot charts with error bars and bubble charts as useful adjuncts to tabular reporting. These graphical tools organize and present complex (even multidimensional) data that directly address important business decisions.

INTRODUCTION

In the credit card industry, many of our prospects are solicited via "preapproved" offers. These offers are extended based on *a priori* knowledge of creditworthiness and financial behavior derived from an analysis of data obtained from a credit bureau. However, some credit card issuers also buy prospect names through list brokers. Since there is little or no credit or financial behavior data on these prospects, they do not receive a preapproved offer.

List brokers are an important source for prospect names that have demonstrated some interest or behavior which can be tied into a marketing campaign. For example, subscribers to selected travel magazines may receive card offers featuring the opportunity to accumulate frequent flier miles based on card usage. Or, supporters of an environmental cause may have the opportunity to receive a credit card which will generate a donation to that cause based on card usage.

Direct mail marketing campaigns typically include deliberate testing of random samples of names from many list sources. Analyses identify the best performing lists and categories of lists, and this knowledge drives business decisions affecting subsequent campaigns.

SATISFYING MULTIPLE BUSINESS OBJECTIVES

An organization could choose among multiple objectives when executing a direct mail new account acquisition campaign. The choices may include maximizing:

- Number of responders and/or accounts booked
- Number of creditworthy accounts
- Amount of outstanding dollars booked (e.g. balance transfer requests at the time of application)
- Likelihood of revolving balances over time (strongly related to large balance transfers or debt consolidation from competitors' credit cards)

Business objectives are achieved to the degree that each list source meets or exceeds initial performance hurdles including: response rate, success rate (net acquisition rate), balance transfer penetration rate (for approved accounts), and average balance transfer per approved account. Other metrics of interest typically include some average measure of risk for approved accounts, the number of balance transfer dollars realized per piece mailed, as well as the cost per account. In a campaign based on a variety of list sources, each performance metric is calculated for each list source.

THE TABULAR DATA APPROACH

Many direct mail campaign managers are accustomed to reviewing their campaign results in spreadsheet format (See Table 1). These numerical results alone do not adequately address the real world business decision for two reasons:

First, when analyzing only one performance dimension at a time, the analysis must address the following issues:

- Which lists (or segments) were above average, about average, and below average in performance?
- How do these segments rank relative to each other?
- Are there statistical or substantive performance differences between adjacent segments or lists?
- What patterns, if any, exist in the results?

Dot charts with error bars are a valuable adjunct to tabular results for addressing these business questions.

The second issue is that business decisions are rarely based on a single performance measure. Usually several measures must be analyzed and the numerical results must be easily understood for an informed management decision. Neither pie charts nor simple or complex bar charts can visually summarize and communicate relationships in multidimensional data.

Bubble charts provide an intuitive approach for determining how various list sources are performing on several dimensions simultaneously.

EVALUATING LIST PERFORMANCE ON A SINGLE DIMENSION WITH DOT CHARTS

The dot chart in Figure 1 shows response rates for each list source based on data in Table 1. There are several conventions incorporated into this graph which are worth mentioning.

The various lists are sorted in descending order based on the selected performance measure (in this case response rates). A vertical reference line identifies the average response rate (for the for all lists combined) and its value is printed at the bottom of the chart.

Error bars, in this example representing a 95% confidence interval, are constructed around each observed response rate. Overlapping error bars indicate no statistically significant difference at the specified level of confidence.

The accompanying Dot Chart Report in Table 2 provides all plotted values (including upper and lower limits for each confidence interval) sorted in the same order as the graph to facilitate data verification. This report also shows the average response rate.

This dot chart and its accompanying report reveal the following:

The majority of the list sources can be grouped into one of the following categories: charitable organizations and causes, subscription magazines and publications, and environmental causes. The remaining list sources could be considered as a miscellaneous group.

No one group of lists dominates the others when response rate is considered.

List sources for charitable and environmental organizations and causes have a tendency to be somewhat less responsive than subscription magazines and publications. These less responsive lists gravitated toward the middle to bottom of the chart. However, the hypothetical "Caregivers Digest" pulled significantly more responders than any of the other lists, and illustrates an exception.

Depending on their placement near and above the middle of chart, those lists associated with subscription magazines and publications tend to be among the better performers on the response performance.

DISCUSSION

As an adjunct to Table 1, the dot chart with error bars and its corresponding report greatly facilitate the discovery of patterns in the response rates of the various lists, as well as highlighting the extraordinary pulling power of the "Caregivers Digest" list source.

In practice, dot charts and their corresponding reports are automatically produced for the following performance measures:

- Response Rate
- Approval Rate (a rough indicator of list source creditworthiness)
- Success Rate (Net Acquisition Rate)
- Balance Transfer Penetration Rate
- Average Balance Transfer Amount in Dollars

The program used at Fleet Credit Card Services to produce this example reads multiple spreadsheets from a workbook using DDE and produces five charts (one for each performance measure identified immediately above) and five tables for each spreadsheet. Each spreadsheet typically contains the results from one major list-testing effort within a campaign. A typical workbook contains five or more spreadsheets containing seventy-five or more lists. Macros are used extensively to streamline the production effort.

USING BUBBLE CHARTS FOR QUADRANT ANALYSIS

Bubble charts permit list performance evaluation on three performance criteria simultaneously. There are four bubble charts which have been useful in evaluating list-based acquisition campaigns, and a separate chart is used to present each of the following sets of performance variables:

- Response Rate, Approval Rate, and Balance Transfer Penetration Rate
- Response Rate, Approval Rate, and Average Balance Transfer in Dollars
- Success Rate, Balance Transfer Penetration Rate, and Average Balance Transfer in Dollars
- Success Rate, Balance Transfer Penetration Rate, and Average Balance Transfer Dollars per Piece Mailed

Figure 2 depicts the results for the last combination of performance variables (immediately above) using the data in Table 1. The following conventions which were used in constructing the bubble chart in Figure 2:

The average values for the x and y axis performance variables determine the horizontal and vertical reference lines respectively.

The vertical and horizontal reference lines divide the chart surface into four quadrants positioned as follows:

IV. Mixed Results	I. Best Performers
III. Worst Performers	II. Mixed Results

The ranked value of the third performance measure, based on quartiles, determines the size of each bubble. Using four sizes allows the reader to easily distinguish differences in bubble sizes while allocating ample space to print the value of the third performance measure inside the bubble.

Each bubble's respective list identification is automatically printed at the top of the bubble but it can be moved to any clock position as needed to reduce congestion among overlapping or closely spaced bubbles.

When there are a large number of lists (e.g. 25 or more) the chart gets cluttered such that bubbles and their labels overlap each other. Our convention is to combine the worst performers into a single bubble labeled "Other." The detailed information for each list that was combined to create the "Other" bubble is preserved in Table 3 where the STATUS column clearly identifies such lists.

"Dithering" (a series of deliberate, but small, position adjustments) is employed as a method of removing overlap between bubbles. Dithering does not affect the values of the performance measures which appear the corresponding report.

A brief look at Figure 2 reveals the following:

The Best Performers, located in Quadrant I, are above average in both Success Rate and Balance Penetration Rate. In contrast, sources in Quadrant II are below average performers on the y axis performance variable, while list sources in Quadrant IV are below average performers on the x axis variable. As expected, the "Other" bubble is located in Quadrant III, since the worst performers were combined to create this bubble.

The Best Performers also have the highest values for the third performance variable while the "Other" bubble, which represents the twelve worst performing list sources, has the lowest value for the third performance variable.

The distance any bubble is from the upper right hand corner of the plotted chart intuitively indicates how that list is performing perform vis-à-vis the x and y performance measures. Note that the bubbles which are furthest from that corner also tend to be the smallest, indicating very weak performance on the third performance variable. The chart thus visually confirms an expected pattern or relationship in the data.

The Bubble Chart Report in Table 3 was developed to facilitate data verification and it has also been very useful in keeping discussions focused on data issues. Several points about Table 3 include:

The lists within each quadrant are sorted in descending order based on their respective values for the x axis variable (success rate) since this measure is typically regarded as the most important of the three performance measures.

In this set of contrived results, readers may note that when the STATUS "Other" appears in the table, it is likely to be associated with lists representing charitable and environmental causes.

The table presents not only overall averages but also the median value for all lists for all three performance measures.

The Quadrant Oriented List Source Report in Table 4 was developed as a quick aid for identifying the full name for each list source represented by each bubble. This listing is organized by quadrants spatially located to graphically emulate the bubble chart quadrants. Currently, within each quadrant of the report the list sources are sorted by the y axis variable so that the first list source in each quadrant of the table will also be the list source highest on the y axis in each quadrant of the chart. The chart and table are visually congruent with each other.

DISCUSSION

The bubble chart and its accompanying reports enable marketing staff to quickly identify not only the best performers but also several list sources whose overall performance is lackluster but potentially viable. Consider, for example list PM05 in Quadrant IV and lists PM12 and PM19 in Quadrant II. List PM05 has a respectable balance transfer penetration rate but a success rate which is slightly below average. The other two lists have solid success rates but are slightly below average on balance transfer penetration.

Response rate is a powerful component of success rate, and it is a performance factor which can be manipulated. Thus, in a future campaign an enticement (such as a free gift subscription when a new account is first used) might be offered to prospects on list PM05. This might produce better a better success rate, with results similar to the other lists found in Quadrant I. Similarly, in a future mailing to prospects on lists PM12 and PM19, the solicitation offer might emphasize an incentive, receipt of which is contingent on the eventual approval of a large balance transfer.

Insights suggesting possible offer features tailored to achieving specific results from an identifiable group of similar prospects could not have been determined as easily from tabular data alone.

Four separate charts and eight reports are typically produced for a given spreadsheet containing the performance measures for a family of lists being tested. The program is robust enough to process multiple spreadsheets in the same workbook using DDE. The result is production oriented, requiring little effort to automatically produce numerous plots, each with supporting reports.

CONCLUSION

Dot charts and bubble charts are powerful data visualization tools for discovering, confirming, summarizing, and communicating patterns and relationships in a data set. Dot charts are appropriate when the analysis focuses on only a single performance measure. Bubble charts are appropriate when the business decision depends on analysis of up to three performance measures simultaneously.

In addition to these charts, intuitively designed supporting tables can improve the chances of discovering useful patterns and relationships while further simplifying the analysis task.

SAS/GRAPH software provides several advantages over other software packages which produce presentation quality custom graphics. First, the production of graphics to address specific business decisions can be done very efficiently, especially where many sets of these graphics are needed regularly. Second, the production of supporting tabular reports can be integrated into the production process with very little additional effort.

Prototype code for both types of charts can be found in Michael Friendly's outstanding reference on statistical graphics.

REFERENCES

Friendly, Michael (1991) SAS® System for Statistical Graphics, SAS Institute Incorporated.

CONTACT INFORMATION

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Table 1: Sample Direct Mail Campaign Performance Summary Report (Contrived Data)

	POTPOURRI SERIES											
Keycode	**List Description**		**Mailbase**	**Responses**	**RR%**	**Approvals**	**AR%**	**SR%**	**# BT**	**BT%**	**Avg BT $**	**Total BT $**	**BT $ /Piece**
PM02	Science Fiction Monthly		20,020	3,947	19.71%	1,212	30.70%	6.05%	1,084	89.48%	$4,849	$5,257,157	$263
PM03	Lifestyle Selector (RS)		20,020	3,113	15.55%	1,250	40.15%	6.24%	1,014	81.09%	$5,123	$5,192,157	$259
PM04	Inner Peace		19,362	2,276	11.75%	658	28.93%	3.40%	448	68.03%	$5,204	$2,330,558	$120
PM05	Science Digest		20,020	2,276	11.37%	925	40.67%	4.62%	778	84.05%	$5,485	$4,266,446	$213
PM06	UTNE Readers		30,030	3,579	11.92%	2,452	68.51%	8.17%	2,062	84.11%	$5,016	$10,344,934	$344
PM08	Onsat Magazine		20,020	2,334	11.66%	1,383	59.28%	6.91%	1,131	81.78%	$5,639	$6,380,002	$319
PM09	Wired Magazine		20,020	1,837	9.17%	1,202	65.46%	6.00%	849	70.58%	$4,986	$4,230,715	$211
PM12	Atlantic Monthly		20,020	3,790	18.93%	1,345	35.50%	6.72%	1,061	78.84%	$4,449	$4,718,989	$236
PM14	Clean Environment Coalition		40,040	1,756	4.39%	1,765	100.52%	4.41%	1,402	79.45%	$5,594	$7,844,717	$196
PM15	Birdwatchers Guide		25,915	1,931	7.45%	1,135	58.81%	4.38%	907	79.93%	$4,862	$4,412,542	$170
PM16	Fish & Oceans		40,040	3,897	9.73%	2,128	54.59%	5.31%	1,768	83.09%	$5,573	$9,852,006	$246
PM17	Rivers and Streams		40,040	2,665	6.66%	1,736	65.15%	4.34%	1,320	76.01%	$4,583	$6,049,420	$151
PM18	National Park Trust		43,564	6,737	15.47%	1,679	24.92%	3.85%	1,084	64.57%	$4,590	$4,977,181	$114
PM19	Trees & Birds		40,040	6,921	17.29%	2,967	42.87%	7.41%	2,310	77.85%	$5,125	$11,838,051	$296
PM20	Air, Earth, and Living		40,040	954	2.38%	544	57.00%	1.36%	412	75.85%	$4,543	$1,874,057	$47
AZ37	Birds and Blooms		30,294	1,792	5.91%	1,288	71.88%	4.25%	1,096	85.09%	$4,448	$4,875,351	$161
PM22	Lifestyle Selector Environmental		44,526	4,641	10.42%	2,538	54.69%	5.70%	2,180	85.91%	$5,196	$11,329,352	$254
PM23	Behavior Bank Environmental		48,246	6,446	13.36%	3,454	53.58%	7.16%	3,029	87.69%	$4,651	$14,085,689	$292
PM25	American Heart Association		29,512	959	3.25%	611	63.70%	2.07%	389	63.69%	$5,031	$1,956,606	$66
PM26	Helping Hands		22,610	963	4.26%	830	86.19%	3.67%	589	70.99%	$5,755	$3,390,923	$150
PM27	Caregivers Digest		22,610	5,783	25.58%	2,013	34.81%	8.90%	1,520	75.52%	$4,652	$7,071,874	$313
PM28	March of Dimes		22,280	869	3.90%	658	75.75%	2.95%	530	80.56%	$5,470	$2,901,026	$130
PM29	Friends and Neighbors		22,610	2,267	10.03%	1,078	47.56%	4.77%	872	80.89%	$5,284	$4,608,424	$204
PM31	Compassionate Friends		32,620	2,446	7.50%	1,450	59.29%	4.45%	1,261	86.95%	$4,560	$5,750,008	$176
PM32	Telefund		22,610	999	4.42%	696	69.72%	3.08%	483	69.38%	$4,331	$2,092,513	$93
PM33	Viguerie		22,610	1,384	6.12%	1,097	79.27%	4.85%	872	79.48%	$5,966	$5,202,795	$230
PM34	National Easter Seals		22,610	1,850	8.18%	1,135	61.37%	5.02%	919	80.96%	$5,170	$4,752,973	$210
PM35	Lifestle Selector Charity Donors		32,620	3,086	9.46%	1,517	49.15%	4.65%	1,226	80.79%	$4,410	$5,404,676	$166
	Subtotal Potpourri Series		814,949	81,497	10.00%	40,750	50.00%	5.00%	32,598	80.00%	$5,000	$162,991,144	$200

Figure 1: Sample Dot Chart with Error Bars

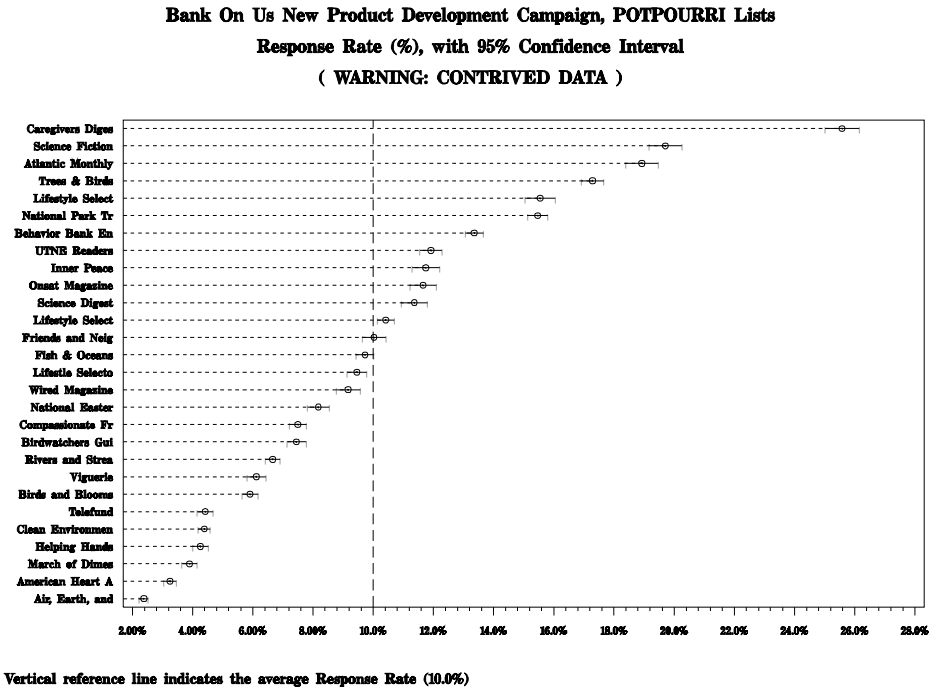


Table 2: Sample Dot Chart Report

Bank On Us New Product Development Campaign, POTPOURRI Lists

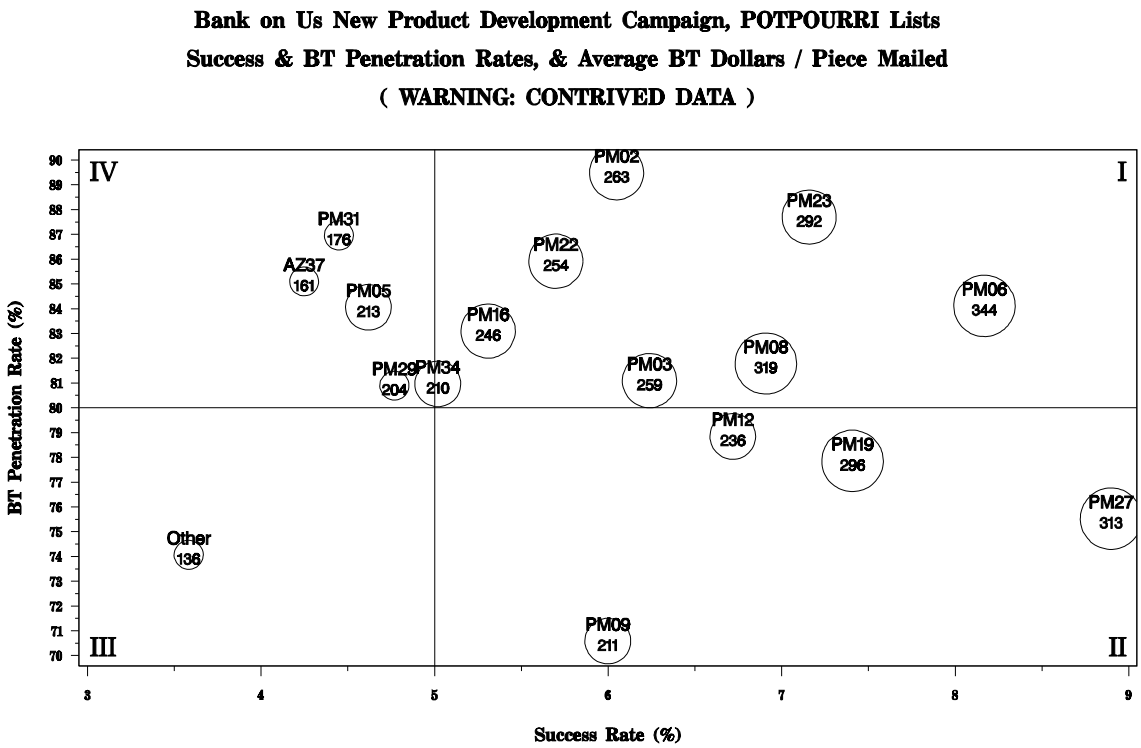
Response Rate (%), with 95% Confidence Interval

(WARNING: CONTRIVED DATA)

KEY	Mail List	Mailbase	Lower Limit	Response Rate (%)	Upper Limit
PM27	Caregivers Digest	22,610	25.0%	25.6%	26.1%
PM02	Science Fiction Monthly	20,020	19.2%	19.7%	20.3%
PM12	Atlantic Monthly	20,020	18.4%	18.9%	19.5%
PM19	Trees & Birds	40,040	16.9%	17.3%	17.7%
PM03	Lifestyle Selector (RS)	20,020	15.0%	15.6%	16.1%
PM18	National Park Trust	43,564	15.1%	15.5%	15.8%
PM23	Behavior Bank Environment	48,246	13.1%	13.4%	13.7%
PM06	UTNE Readers	30,030	11.6%	11.9%	12.3%
PM04	Inner Peace	19,362	11.3%	11.8%	12.2%
PM08	Onsat Magazine	20,020	11.2%	11.7%	12.1%
PM05	Science Digest	20,020	10.9%	11.4%	11.8%
PM22	Lifestyle Selector Enviro	44,526	10.1%	10.4%	10.7%
PM29	Friends and Neighbors	22,610	9.64%	10.0%	10.4%
PM16	Fish & Oceans	40,040	9.44%	9.73%	10.0%
PM35	Lifestle Selector Charity	32,620	9.14%	9.46%	9.78%
PM09	Wired Magazine	20,020	8.77%	9.17%	9.57%
PM34	National Easter Seals	22,610	7.82%	8.18%	8.54%
PM31	Compassionate Friends	32,620	7.21%	7.50%	7.79%
PM15	Birdwatchers Guide	25,915	7.13%	7.45%	7.77%
PM17	Rivers and Streams	40,040	6.42%	6.66%	6.90%
PM33	Viguerie	22,610	5.81%	6.12%	6.43%
AZ37	Birds and Blooms	30,294	5.64%	5.91%	6.18%
PM32	Telefund	22,610	4.15%	4.42%	4.69%
PM14	Clean Environment Coaliti	40,040	4.19%	4.39%	4.59%
PM26	Helping Hands	22,610	4.00%	4.26%	4.52%
PM28	March of Dimes	22,280	3.65%	3.90%	4.15%
PM25	American Heart Associatio	29,512	3.05%	3.25%	3.45%
PM20	Air, Earth, and Living	40,040	2.23%	2.38%	2.53%

Average Response Rate 10.00%

Figure 2: Sample Bubble Chart



Quadrants: I. Best Performers, II. Mixed Performers, III. Worst Performers, IV. Mixed Performers

The lowest 12 performers out of 28 are averaged & presented as 'Other' based on the 55th percentile of both performance measures.

Code: h:\gurjohn\maillist_sugi\bplot2.sas Output generated: 21JAN99

Table 3: Sample Bubble Chart Report

Bank on Us New Product Development Campaign, POTPOURRI Lists

Success & BT Penetration Rates, & Average BT Dollars / Piece Mailed

(WARNING: CONTRIVED DATA)

QUAD	KEY	DESC	STATUS	BT_PCT	SR_PCT	BT$/PIECE
I	PM06	UTNE Readers		84.110	8.17	344
	PM23	Behavior Bank Environment		87.690	7.16	292
	PM08	Onsat Magazine		81.780	6.91	319
	PM03	Lifestyle Selector (RS)		81.090	6.24	259
	PM02	Science Fiction Monthly		89.480	6.05	263
	PM22	Lifestyle Selector Enviro		85.910	5.70	254
	PM16	Fish & Oceans		83.090	5.31	246
	PM34	National Easter Seals		80.960	5.02	210
II	PM27	Caregivers Digest		75.520	8.90	313
	PM19	Trees & Birds		77.850	7.41	296
	PM12	Atlantic Monthly		78.840	6.72	236
	PM09	Wired Magazine		70.580	6.00	211
III	PM33	Viguerie	(Other)	79.480	4.85	230
	PM14	Clean Environment Coaliti	(Other)	79.450	4.41	196
	PM15	Birdwatchers Guide	(Other)	79.930	4.38	170
	PM17	Rivers and Streams	(Other)	76.010	4.34	151
	PM18	National Park Trust	(Other)	64.570	3.85	114
	PM26	Helping Hands	(Other)	70.990	3.67	150
	PM04	Inner Peace	(Other)	68.030	3.40	120
	PM32	Telefund	(Other)	69.380	3.08	93
	PM25	American Heart Associatio	(Other)	63.690	2.07	66
	PM20	Air, Earth, and Living	(Other)	75.850	1.36	47
IV	PM29	Friends and Neighbors		80.890	4.77	204
	PM35	Lifestle Selector Charity	(Other)	80.790	4.65	166
	PM05	Science Digest		84.050	4.62	213
	PM31	Compassionate Friends		86.950	4.45	176
	AZ37	Birds and Blooms		85.090	4.25	161
	PM28	March of Dimes	(Other)	80.560	2.95	130
		Median Value (All Lists)		80.245	4.71	207
		Campaign Average		80.000	5.00	200

Quadrants: I. Best Performers, II. Mixed Performers, III. Worst Performers, IV. Mixed Performers

Table 4: Sample Quadrant Oriented List Report

Bank on Us New Product Development Campaign, POTPOURRI Lists

Success & BT Penetration Rates, & Average BT Dollars / Piece Mailed

(WARNING: CONTRIVED DATA)

Quadrant	Key	Description	Status	Quadrant	Key	Description	Status
IV	PM31	Compassionate Friends		I	PM02	Science Fiction Monthly	
	AZ37	Birds and Blooms			PM23	Behavior Bank Environment	
	PM05	Science Digest			PM22	Lifestyle Selector Enviro	
	PM29	Friends and Neighbors			PM06	UTNE Readers	
	PM35	Lifestle Selector Charity	(Other)		PM16	Fish & Oceans	
	PM28	March of Dimes	(Other)		PM08	Onsat Magazine	
					PM03	Lifestyle Selector (RS)	
					PM34	National Easter Seals	
III	PM15	Birdwatchers Guide	(Other)	II	PM12	Atlantic Monthly	
	PM33	Viguerie	(Other)		PM19	Trees & Birds	
	PM14	Clean Environment Coaliti	(Other)		PM27	Caregivers Digest	
	PM17	Rivers and Streams	(Other)		PM09	Wired Magazine	
	PM20	Air, Earth, and Living	(Other)				
	PM26	Helping Hands	(Other)				
	PM32	Telefund	(Other)				
	PM04	Inner Peace	(Other)				
	PM18	National Park Trust	(Other)				
	PM25	American Heart Associatio	(Other)				

Quadrants: I. Best Performers, II. Mixed Performers, III. Worst Performers, IV. Mixed Performers