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Fast Dashboards Anywhere with SAS® Visual Analytics

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ABSTRACT

Dashboards can be the best starting point to provide a high-level view of the most relevant information to monitor, analyze, and collaborate around business performance. A growing number of organizations are creating dashboards to improve fact-based decision making, but if the dashboards fail to return results quickly or are difficult to understand, user adoption will soon wane. SAS® Visual Analytics includes an authoring interface called Designer that lets you build responsive, well-formatted, and effective dashboards that enable users to:

- Place, size, and style objects precisely.
- Interact between objects.
- Drill and expand.
- Collaborate.
- Share results on the Web and mobile devices.

SAS Visual Analytics provides fast, effective dashboards anywhere, regardless of how big your data might be.

INTRODUCTION

Dashboards have quickly evolved from a promising alternative to a plethora of detailed reports to become the front door to BI for most managers and executives. They can easily access both attractive and effective dashboards, if properly designed, which allow them to monitor the most important business metrics at a glance. Although most organizations have already implemented dashboards to some degree, recently published research has shown that organizations continue to rank dashboards number one for their future BI investments, and most consider their existing dashboard implementations successful. Perhaps early success has led to greater demand. However, big data can make dashboard performance a big challenge. Many early dashboards were designed poorly, sometimes created by a stand-alone dashboard tool and often required separate and pre-summarized tables or cubes to achieve just reasonable performance. Likewise, technical skills were often required, so many business users could not easily create them. Links from dashboards to detailed reports created in different tools and technologies so that dashboard users could ask, “Why?” required complex integration effort. Dashboards make BI more accessible to more business users, ensuring fact-based decisions more quickly, but can the current state of dashboards improve?

With the release of SAS Visual Analytics, you can now achieve unbelievable performance when displaying dashboards from your web browser or tablet, summarized on the fly from all of your organizations detail data. Technology innovations, such as distributed in-memory computing and native mobile applications have enabled a giant leap in analytical dashboard performance and extended reach. SAS Visual Analytics provides a comprehensive set of BI capabilities including an integrated design environment optimized for dashboard creation and consumption. Results from SAS Visual Analytics Explorer can be included in dashboards, and new dashboards can reuse objects from existing dashboards. Similarly, you can extend SAS Visual Analytics dashboards using the SAS language and procedures by including stored processes as dashboard objects. To enable viewer interactions and navigation, designers can include filter controls on the dashboard, such as date range selection calendars, and they can create hierarchies in the dashboard for drilling and expanding. Designers can establish associations between objects for brush and filter interactions, and the 6.2 release allows creation of links to other tabs within a dashboard or to other SAS Visual Analytics reports and dashboards. Information consumers can find the right dashboards quickly from a central starting point using their browser or tablet. SAS Visual Analytics dashboards are fast, easy to use, and interactive from wherever you need to be.

The best dashboard is a used dashboard. Therefore, designers must understand effective dashboard design principles and techniques. Beyond the scope of this paper, successful dashboard projects should follow proven practices for requirements gathering and prioritization as well as project management. SAS Visual Analytics facilitates dashboard design best practices by providing specific dashboard style visualizations, such as the bullet graph and sparkline. However, any tool could be used to create a poorly designed dashboard that will ultimately not be used by anyone. There are good books, courses, and blogs available for dashboard design principles as well as BI requirements and project management. You will find some of these in the reference and recommended reading sections of this paper. This paper covers some of the establish dashboard design techniques to help get you started down a path to success.

WHAT IS A BI DASHBOARD?

When you are driving down the road, the dashboard in your vehicle lets you monitor your speed, gas level and engine temperature, and so on. You can't afford to take your eyes off the road for more than a split second to decide whether and when to stop for gas or take the car to an auto repair shop to fix an urgent problem. Business managers are busy with meetings, e-mail, travel, and so on, and they have little time to spare. Operational workers on the front-line are working with customers, or keeping business processes moving forward. Speed of information interpretation is essential (Few, 2006). It's imperative that they can monitor and understand key measures that help them accomplish their objectives while at their desk, in a conference room, or on the airport.

Although BI dashboards have been named after the panel under the windshield that you use to monitor the operation of your automobile, early dashboard software and designs perhaps have taken this automobile metaphor too literally. Many BI dashboards have extraneous objects and decoration on the screen to make them appear like actual automobile dashboards, and it has been common for indicators to look just like speedometers and fuel gauges. There are more effective display types for dashboards than radial gauges that will help users understand the information more efficiently.

So what exactly is a BI dashboard supposed to be? Stephen Few, a data visualization specialist and author, wrote a book in 2006 entitled *Information Dashboard Design*. Stephen is also the founder of Perceptual Edge, a consultancy that helps organizations design simple information displays for effective analysis and communication. As a BI vendor, SAS uses design principles and best practices presented in Stephen's books to improve the visualization capabilities in SAS Visual Analytics. Stephen offered a clear and succinct definition of BI dashboards for the first time in a 2004 article "Dashboard Confusion," because he struggled to find a definition at that time from BI vendors, data warehousing magazine articles, and so on. Many referred to dashboards without actually defining them. In this article, Stephen proposed the following vendor independent definition based on how dashboards display information to serve a particular purpose.

> "A dashboard is a visual display of the most important information needed to achieve one or more objectives; consolidated and arranged on a single screen so the information can be monitored at a glance."

Committing this concise definition to memory helps you keep the target user's responsibilities and information needs in mind when choosing the placement, format, and types of information displays in your dashboards.

BI dashboards have their roots in Executive Information Systems (EISs) and Decision Support Systems of the late 1980s and early 1990s. An EIS was designed to help a small number of executives measure and monitor performance. These systems often required custom application development. As a result, they were difficult to enhance and maintain. Later in the 1990s Robert S. Kaplan and David P. Nortan's Balanced Scorecard approach to Business Performance Management became popular and introduced key performance indicators (KPIs). Once companies had constructed data warehouses and vendors' BI technology evolved, the EIS concept was resurrected as digital dashboards early in the first decade of the century. Following the Enron scandal in October 2001, executives and managers at every level became increasingly more accountable for measuring and monitoring key facts about their businesses. After two decades, the vision of BI dashboards and Executive Information Systems remains virtually the same, though dashboards are usually updated more frequently and aim to reach a broader audience than just a few executives.

There are various ways to categorize types of dashboards. Generally, dashboards can be considered either management or operational. Going further, management dashboards can be subdivided into strategic and tactical. Strategic dashboards enable organizational alignment with strategic objectives, and they often require specific capabilities as either a stand-alone offering or as an add-on to more general purpose BI technology. SAS has an offering called SAS Strategy Management for strategic dashboards, which can be used stand-alone or enhanced with SAS Visual Analytics. For eaxmple, SAS Visual Analytics extends viewing SAS Strategy Management KPIs to mobile users. Tactical dashboards do not map metrics to strategic goals and objectives, and might focus on a single initiative. Regardless, management dashboards display summary data that is updated periodically, often designed by business users, and notifications are not as important. Conversely, operational dashboards have historically been custom built by the IT department based on near-real-time data where notification of exceptions is essential. Operational dashboards are used to monitor business processes, activities, and events. SAS provides technology to address both management and operational needs, and dashboards created in SAS Visual Analytics 6.1 are most suitable for tactical management dashboards.

DEMAND FOR DASHBOARDS

Dashboards are not new, but they have gone from hype to mainstream quickly relative to other BI trends. Despite the design and user adoption challenges that remain, research has shown that many dashboards projects have been considered successful (2012, Howson), so you might conclude that with mature technology and deployments dashboard projects are reaching a plateau. Most innovations that you hear about in BI these days include big data, visual data discovery, mobile delivery, search, collaboration, and cloud BI. Therefore, it might be surprising to learn that dashboards were rated the top priority for expansion and innovation in Cindi Howson's report from BI Scorecard,"2012 Successful BI Survey: Best Practices in Business Intelligence for Greater Business Impact." Cindi Howson is the founder of BI Scorecard, and author of *Successful Business Intelligence: Secrets to Making BI a Killer App*, a TDWI faculty member, and a contributor to *Information Week*. Figure 1 from Cindi's report shows percentage of survey respondents to improvements and innovation priorities by BI initiatives.

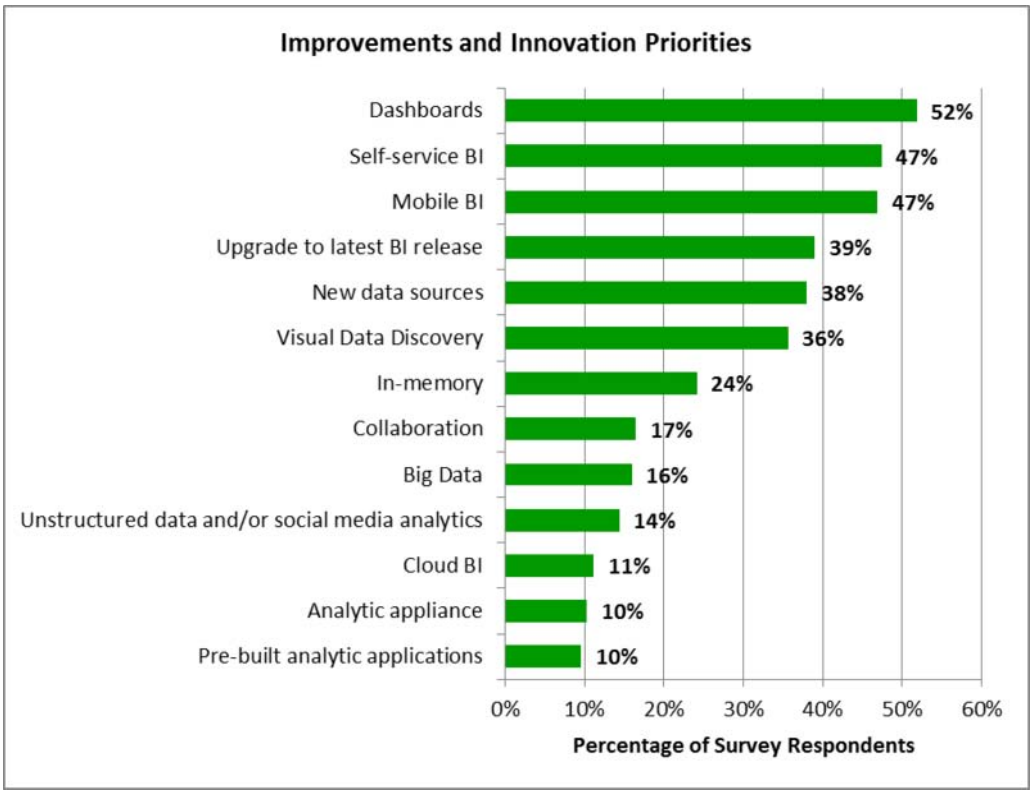


Figure 1: Survey Responses to Investment Priorities

Cindi summarizes the results of this survey in her blog post from January 24, 2013. Perhaps dashboards are the number one trend because they are easier to build and consume compared to other forms of BI. It could be that dashboards have delivered more relevant information to business managers because dashboards are better aligned with business priorities. Technology innovations in big data and mobile delivery have transformed dashboard speed, and interactivity no matter where you are. With improved relevancy, agility, and mobility, dashboard popularity is still growing.

OVERVIEW OF SAS VISUAL ANALYTICS

SAS Visual Analytics is not just a tool for dashboards. SAS Visual Analytics is a web-based product that uses SAS high-performance analytic technologies to explore huge volumes of data quickly in order to see patterns and trends and publish results. The visual, drag-and-drop data exploration and design interfaces, combined with the in-memory technology used by SAS LASR Analytic Server, accelerate analytic computations and enables organizations to derive value from massive amounts of data. SAS Visual Analytics enables business users, business analysts, and IT administrators to accomplish tasks from an integrated suite of applications that are accessed from a common home page. The central entry point for SAS Visual Analytics enables users to perform a variety of tasks such as preparing data, exploring data, designing dashboard-style reports, as well as analyzing and interpreting results. Reports can also be displayed on a mobile device or in a web viewer.

SAS Visual Analytics provides users with the following benefits:

- enables users to apply the power of SAS analytics to massive amounts of data
- empowers users to visually explore data, based on any variety of measures, at amazingly fast speeds
- enables users to share insights with anyone, anywhere, via the web or a mobile device

You can use SAS Visual Analytics to explore and view data, interact with and create reports and dashboards, and display results on a mobile device or in a web viewer. You can explore your data by using interactive visualizations such as charts, histograms, and tables. Report authors can easily point and click to query central sources of data. You can add filters and design the layout using tables, graphs, and gauges using drag and drop to create a well-formatted dashboard style report.

The most current release is SAS Visual Analytics 6.1, and the 6.2 release is expected to be available in summer 2013.

Figure 2 that follows illustrates how the different pieces of SAS Visual Analytics work together. It also shows how users interact with the different interfaces (2012, SAS Institute Inc.).

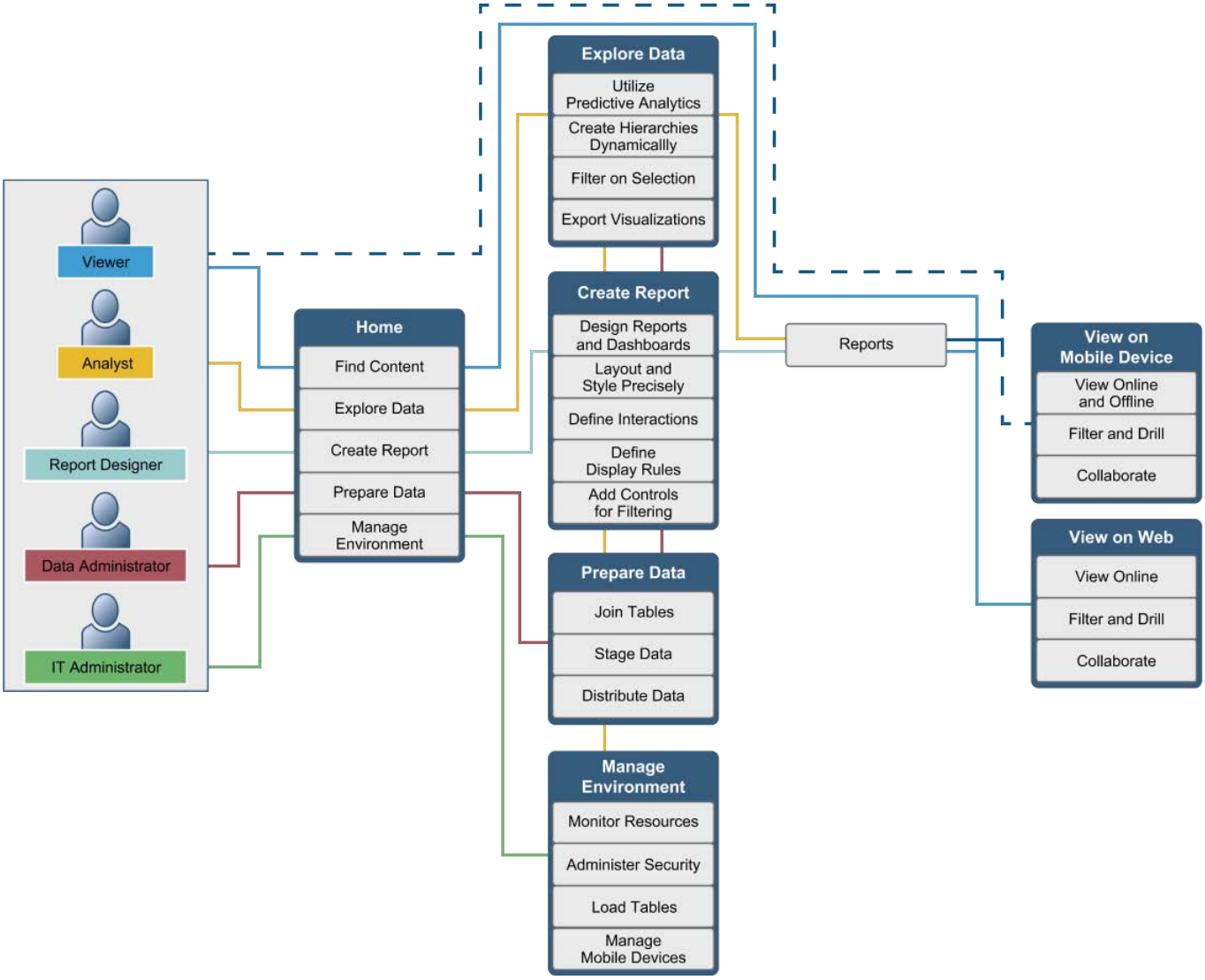


Figure 2: Different User Roles & Various Capabilities

Users might have access to different functionality, depending on their assigned roles. SAS Visual Analytics is shipped with three predefined roles, including Report Viewing, Analysis, and Administration. Your administrators can modify these roles or define new roles.

THE NEED FOR SPEED

What makes SAS Visual Analytics so fast?

Dashboards have the potential to reach the broadest audience, if they are well designed, relevant and fast. According to the latest edition of "The Successful BI Survey," published annually by BI Scorecard.com, user adoption of BI in 2012 was approximately 24% of all employees, which has been basically the same each year since the first report was published in 2007 (2012, Howson). There are many factors revealed in this report that contribute to success and value of BI with the primary being cultural and organizational. Many challenges still exist including usability, information relevance, data quality, and organizational awareness, just to name a few. However, If a dashboard or report takes too long to process and render on the screen, user satisfaction and overall adoption will be low regardless of quality, relevance, and so on. We've grown accustom to near instantaneous search results from Google and Bing, so a dashboard that takes more the 5 seconds to render is not likely going to be used frequently by busy executives, managers, or frontline workers. When it comes to dashboards, speed of rendering and interpreting the results is essential for success.

As stated in the previous section, SAS Visual Analytics leverages the SAS LASR Analytic Server to accelerate analytic computations on massive amounts of data. The SAS LASR Analytic Server is an in-memory analytic platform that provides a secure, multi-user environment for concurrent access to data that is loaded into memory. The server can handle smaller data sets, but is designed for applying analytics to big data. When working with big data, it takes advantage of the processing power that is available in a distributed computing environment. SAS Visual Analytics Administrator provides a point-and-click interface to manage SAS LASR Analytic Server. You can load tables into the server with SAS Visual Analytics Administrator or SAS Visual Data Builder. SAS Visual Analytics includes SAS LASR Analytic Server, the key enabler for analytics and speed.

The server handles both big data and smaller sets of data, and it is designed with a high-performance, multi-threaded, analytic code. The server processes client requests at extraordinarily high speeds due to the combination of hardware and software that is designed for rapid access to tables in memory. By loading tables into memory for analytic processing, the SAS LASR Analytic Server enables business analysts to explore data and discover relationships in data at the speed of RAM.

The architecture was originally designed for optimal performance in a distributed computing environment. A distributed SAS LASR Analytic Server runs on multiple machines. A typical distributed configuration is to use a series of blades as a cluster. Each blade contains both local storage and large amounts of memory. In this analytic environment, many gigabytes of RAM per blade is common. Local storage is used to store large data sets in distributed form. Data is loaded into memory and made available so that clients can quickly access that data.

For distributed deployments, having local storage available on machines is critical in order to store large data sets in a distributed form. The SAS LASR Analytic Server supports the Hadoop Distributed File System (HDFS) as a co-located data provider. HDFS is used because the server can read from and write to HDFS in parallel. In addition, HDFS provides replication for data redundancy. HDFS stores data as blocks in distributed form on the blades and the replication provides failover capabilities.

In a distributed deployment, the server also supports some third-party vendor databases as co-located data providers. Teradata Data Warehouse Appliance and Greenplum Data Computing Appliance are massively parallel processing database appliances. You can install the SAS LASR Analytic Server software on each of the machines in either appliance. The server can read in parallel from the local data on each machine.

For the SAS LASR Analytic Server 1.6 release (concurrent with the SAS Visual Analytics 6.1 release) the server supports a non-distributed deployment. A non-distributed SAS LASR Analytic Server can perform the same in-memory analytic operations as a distributed deployment server. A non-distributed deployment does not support SAS High-Performance Deployment of Hadoop or third-party vendor appliances as co-located data providers (2012, SAS Institute Inc.).

You can visit this SAS Voices blog, "What's new with in-memory computing?," with Oliver Schabenberger and Alison Bolen to read more about SAS LASR Analytic Server.

CREATING DASHBOARDS WITH SAS VISUAL ANALYTICS DESIGNER

You can create dashboards using SAS software without a license for SAS Visual Analytics. SAS/GRAPH® software includes a number of procedures that SAS programmers can use to create almost any type of graph for use in a dashboard with a great deal of control and flexibility (2006, SAS Institute Inc.). SAS 9.2 added a new procedure GKPI to SAS/GRAPH for dashboard-specific display types, such as the bullet graph and slider, including range bands and actual and target values. The ANNOTATE® facility included in SAS/GRAPH allows advanced programmers to customize the built-in graph types or create new ones. Once you have your graphs, the included GREPLAY procedure lets you arrange the various graphs on your dashboard. In addition, SAS Enterprise BI Server® includes the SAS BI Dashboard that provides a browser-based point-and-click interface for constructing and viewing dashboards that can link to other dashboards or SAS Web Report Studio reports. SAS Visual Analytics Designer is the latest way, but not the only way, to create dashboard-style reports with SAS.

SAS Visual Analytics Designer is a web browser interface within the SAS Visual Analytics product that enables business users to easily create dashboard-style reports. It's important for dashboard users to be able to monitor information from multiple data sources on the same screen. As a designer, you can point and click to select one or more sources of data, and drag-and-drop text, tables, graphs on to a report canvas. You can modify properties associated with each data item, such as labels and the function used to aggregate measures, and you can define new hierarchies for drilldown within a table or graph. You can toggle between tile and precision layout mode, and style and size each of the report objects. When you drag data items to the tables and graphs, you see results almost immediately on the report canvas, which makes it easier for you to style and size the objects. Display rules let you highlight values to bring attention to exceptions. Filter controls, such as a drop down selector, list and range slider, can be placed and sized anywhere on the report. Once you have data and objects, you can establish relationships between some or all of the tables and graphs such that selecting a value on one object will either filter or highlight the selection in other objects from the same data source. Important to dashboard-style reports, you can create links to different sections within the same dashboard or to a different SAS Visual Analytics 6.2 report with the ability to pass the filter context from the source dashboard to the target. Linking facilitates a layered approach to information consumption and investigation by navigating from highly summarized dashboards to other dashboards or more detailed reports. Once saved, these dashboards can be viewed on a supported tablet and web browser. SAS Visual Analytics Designer provides the tools that you need to create a well-designed dashboard.

As an author, you can include existing SAS content in a new or existing dashboard as well. You can import one or more objects from an existing SAS Visual Analytics report, including those created in the design and exploration interfaces within SAS Visual Analytics. This allows for reuse and consistency across multiple dashboard-style reports. The visualizations created by SAS Visual Analytics Explorer that are imported enable you to add rich analytical content, such as a sales forecast, to your dashboards. Likewise, analytical results from SAS stored processes can be added to the report canvas alongside other dashboard content as well. With rich analytics content, your dashboards can help business users understand what is likely to happen in addition to what has already occurred.

SAS Visual Analytics 6.1, the production release when this paper was written, includes a dark report style or theme. Therefore, some of the examples used in this paper are dark. Dark backgrounds with white or green text were the norm in the 1980s due to limitations of CRT refresh rates. The Apple iPhone and iPad seem to have reintroduced the dark background to make them fashionable again, at least initially. However, a dark background might not be preferred by everyone and might not be the easiest for business managers to interpret. One customer told me they prefer a light dashboard style when using their desktop monitor and dark on their iPad. SAS Visual Analytics 6.1 lets you change the colors of the various text labels, values, and charts using the style tab in the right hand pane of SAS Visual Analytics Designer. In the upcoming 6.2 release, SAS plans to a deliver an alternative report theme that is light as well as the ability to create custom report themes for reuse across multiple dashboards and reports. You cannot have it both ways, light for the web browser and dark for the mobile devices, with the option of light or dark, you should choose based on which makes your dashboards more effective rather than fashion trends or user preferences.

SELECTING THE BEST DISPLAY TYPES FOR DASHBOARDS

SAS Visual Analytics Designer includes a number objects types that you can drag to the report canvas from the left hand pane, including tables, graphs, gauges, controls, text, images, scroll containers, geographical maps, and stored process. The following is a complete list of objects available in SAS Visual Analytics 6.1.

Tables

- list tables
- crosstabs

Graphs

- bar charts
- targeted bar charts
- waterfall charts
- line charts
- pie charts
- scatter plots
- time series plots
- bubble plots
- treemaps
- dual axis bar charts
- dual axis line charts
- dual axis bar-line charts
- dual axis time series plot

Gauges

- bullet
- slider
- thermometer
- dial
- speedometer

Controls

- drop-down lists
- lists
- button bars
- text input fields
- range sliders

Other

- text
- image
- stored processes
- vertical containers
- horizontal containers
- geo maps

In addition to the objects above available in SAS Visual Analytics Designer, you can import report objects exported from SAS Visual Analytics Explorer, including a forecast, histogram, heat map, box plot, and correlation matrix.

Your dashboard should display the most relevant summary information on a single screen without needing to scroll, so choose your object types carefully. There are many object types that could be used for this purpose. However, not all objects are equally effective for use in dashboards. You should consider the responsibilities and objectives of the person needing to monitor the various metrics when choosing objects, arrangement, and sizes for your dashboard designs.

Some objects might be seen frequently on dashboards, such as speedometers or pie charts, but better alternatives usually exist. If the dashboard consumer or stakeholder gives strict requirements to use pies or speedometers, consider implementing and showing them an alternative dashboard with more effective displays in addition to the one with the design options that they chose. If the user and stakeholders like your alternative design, avoid publishing the original as other consumers and designers might become biased to these less effective object types for their dashboard requirements and designs as well. However, if the dashboard user still prefers the original less effective dashboard design, publish both alternatives, and you might find they will actually use the more effective dashboard in the long run.

The following covers a subset of the object types supported by SAS Visual Analytics listed above that are either typical seen or preferred for use on dashboards along with pros and cons for each. Visualizations not mentioned below might be fine for certain types of reports and analyses, but might not be primary types for the quick understanding needs of a dashboard.

List Tables

A list table displays data in rows and columns with data item labels in the column headings and an optional total row with overall aggregated measures at the bottom. You can choose to display detail or aggregated data in the list table rows, though detail data would not be very useful for a dashboard style display. Note that list tables cannot include a hierarchy, unlike a crosstab.

List tables are particularly appropriate for dashboards in many situations because you can include a sparkline and display rules. Figure 3 shows a sparkline for profit, a display rule for negative profit, and a category display rule for product line.

Product Line	Revenue	Expenses	Profit ▼	Profit Trend
Game	1,671,890,035	477,809,929	1,194,080,107	
Promotional	813,699,290	223,822,374	589,876,916	
Stuffed Animal	276,990,966	159,548,680	117,442,285	
Action Figure	262,318,761	281,390,254	-19,071,493	
	Sum: 3,024,899,052	Sum: 1,142,571,237	Sum: 1,882,327,815	

Figure 3: List Table with a Sparkline and Display Rules

In SAS Visual Analytics a sparkline is a small line graph that efficiently shows a trend over time for a single measure data item in a list table. A sparkline is about the size of a word or two, so it fits in a single cell and repeats for each row of a column. The sparkline does not include axes or labels, because the precision of the quantity is not what's important when used with a dashboard. You are just trying to give the consumer enough history of the measure so that they can quickly see the general direction the value is changing over time (Few, 2006). If more precision is needed for a particular sparkline, the list table in the dashboard can be linked to another section or more detailed report with a standard line chart or table. A sparkline shows multiple instances of a trend for one measure at a glance.

Display rules let you highlight individual cells or the entire row of a list table, based on a category or a measure. You can conditionally change the style of the cell, including fonts and cell background color, based on the data. Alternatively, you can display an icon or gauge alongside or in place of a measure value based on the conditions. Display rules help bring attention to exceptions or important information.

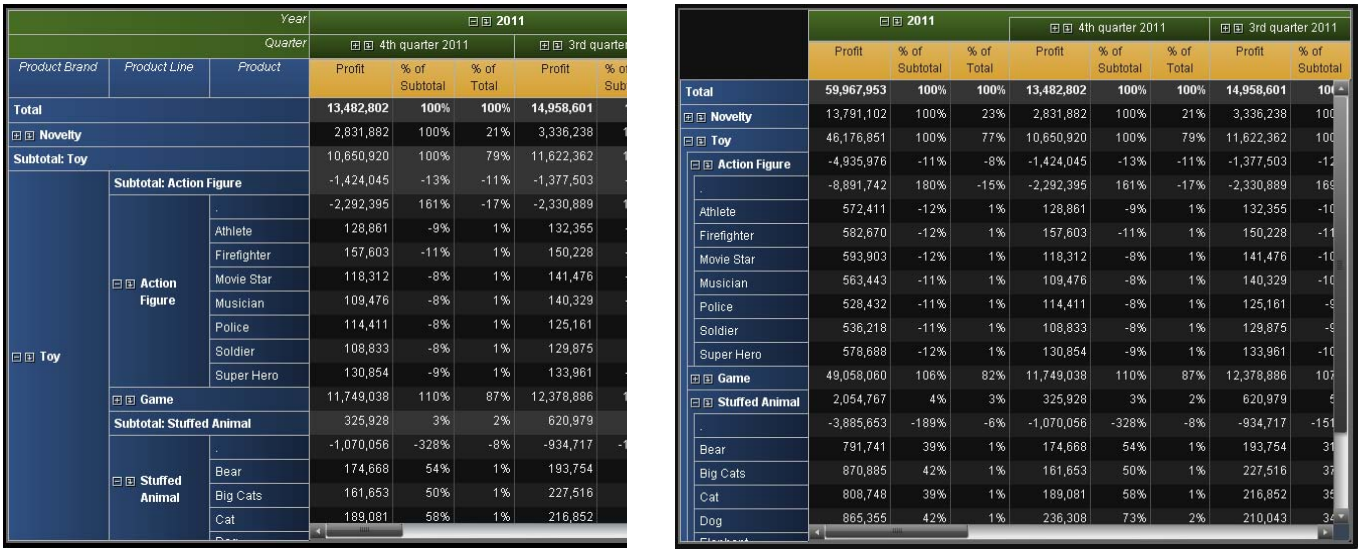
Crosstabs

Crosstabs display data in rows and columns where measures are aggregated based on the combination of category data items, or their intersection. Crosstabs often have two or more categories assigned to both the rows and columns, forming a matrix. They can be easier to read than list tables because they often use less space, and they always collapse repeating values for outer category data items into one unique value, also known as grouping. You can choose to show subtotals and totals for rows, columns or both either before or after the detail. Consider placing lower cardinality (fewer distinct values) categories on the columns and higher cardinality categories on the rows. Crosstabs can help you improve readability especially when there are several category data items to include in your table.

However, crosstabs are not always the better than list tables when you need to show actual values in dashboards for more precision. Display rules, typically used to highlight exceptional values, are not yet allowed for crosstabs in SAS Visual Analytics. Likewise, you currently cannot include a sparkline in a crosstab like you can in an aggregated list table. (See previous section.) These two capabilities are valuable dashboard design features, and will likely be available in SAS Visual Analytics crosstabs in a subsequent release.

Hierarchies can be assigned to crosstabs, unlike list tables. However, they can consume valuable dashboard screen real-estate. Dashboard consumers can expand one or multiple levels on the crosstabs as an alternative to drilling. Drilling conserves space by eliminating the parent levels from the crosstab rows and columns to conserve space by making room for lower levels being dynamically added. Expanding adds lower category levels to the crosstab while retaining the parent levels as well. Viewers can expand one or multiple expansion paths, which is valuable for comparing two lower level categories having different ancestry. However, the amount of space required to display the expanded information can grow significantly, causing the crosstab object to require scrolling to see the valuable measures. You can choose to indent levels in a single column or row to help with this, rather than the default where each level has a separate column or row. Figure 4 below shows a comparison between the default and indented columns when expanded. The overall size of the crosstab object in SAS Visual Analytics does not grow, so scroll bars appear. If the crosstab object did grow, it would push other important information displayed on the dashboard down or to the right, potentially out of view completely. Expanding on crosstabs is valuable for comparison when

exploring data or investigating why an exception occurred. Crosstabs with hierarchies are good candidates for target or destination reports that are linked from a dashboard style report. If you need to display quantitative values for two or more categories in a condensed matrix view, consider using the crosstab with standard category data items rather than hierarchies.



Year			2011				
Quarter			4th quarter 2011			3rd quarter	
Product Brand	Product Line	Product	Profit	% of Subtotal	% of Total	Profit	% of Sub
Total			13,482,802	100%	100%	14,958,601	
Novelty			2,831,882	100%	21%	3,336,238	
Subtotal: Toy			10,650,920	100%	79%	11,622,362	
Toy	Subtotal: Action Figure		-1,424,045	-13%	-11%	-1,377,503	
	Action Figure	.	-2,292,395	161%	-17%	-2,330,889	
		Athlete	128,861	-9%	1%	132,355	
		Firefighter	157,603	-11%	1%	150,228	
		Movie Star	118,312	-8%	1%	141,476	
		Musician	109,476	-8%	1%	140,329	
		Police	114,411	-8%	1%	125,161	
		Soldier	108,833	-8%	1%	129,875	
		Super Hero	130,854	-9%	1%	133,961	
	Game		11,749,038	110%	87%	12,378,886	
	Subtotal: Stuffed Animal		325,928	3%	2%	620,979	
	Stuffed Animal	.	-1,070,056	-328%	-8%	-934,717	
		Bear	174,668	54%	1%	193,754	
		Big Cats	161,653	50%	1%	227,516	
		Cat	189,081	58%	1%	216,852	

	2011			4th quarter 2011			3rd quarter 2011	
	Profit	% of Subtotal	% of Total	Profit	% of Subtotal	% of Total	Profit	% of Subtotal
Total	59,967,953	100%	100%	13,482,802	100%	100%	14,958,601	10
Novelty	13,791,102	100%	23%	2,831,882	100%	21%	3,336,238	10
Toy	46,176,851	100%	77%	10,650,920	100%	79%	11,622,362	10
Action Figure	-4,935,976	-11%	-8%	-1,424,045	-13%	-11%	-1,377,503	-1
.	-8,891,742	180%	-15%	-2,292,395	161%	-17%	-2,330,889	16
Athlete	572,411	-12%	1%	128,861	-9%	1%	132,355	-1
Firefighter	582,670	-12%	1%	157,603	-11%	1%	150,228	-1
Movie Star	593,903	-12%	1%	118,312	-8%	1%	141,476	-1
Musician	563,443	-11%	1%	109,476	-8%	1%	140,329	-1
Police	528,432	-11%	1%	114,411	-8%	1%	125,161	-9
Soldier	536,218	-11%	1%	108,833	-8%	1%	129,875	-9
Super Hero	578,688	-12%	1%	130,854	-9%	1%	133,961	-1
Game	49,058,060	106%	82%	11,749,038	110%	87%	12,378,886	10
Stuffed Animal	2,054,767	4%	3%	325,928	3%	2%	620,979	5
.	-3,885,653	-189%	-6%	-1,070,056	-328%	-8%	-934,717	-15
Bear	791,741	39%	1%	174,668	54%	1%	193,754	3
Big Cats	870,885	42%	1%	161,653	50%	1%	227,516	3
Cat	808,748	39%	1%	189,081	58%	1%	216,852	3
Dog	865,355	42%	1%	236,308	73%	2%	210,043	3

Figure 4: Expanded Hierarchies Not Indented Versus Indented

For dashboards specifically, hierarchies on graphs can be a better alternative to crosstabs. Because only drill navigation, and not expanding, is allowed, a drill operation replaces the bars from the previous level conserving space and minimizing the appearance of scroll bars. If your dashboard users occasionally need drill navigation with more detail and precise values a contextual link from a dashboard to an expandable crosstab in a separate section/tab or separate report might be a better design alternative to preserve valuable space on the primary dashboard.

Bar Charts

Bar charts display one or more measures for multiple values of a category data item. Bars are best used when you need to display quantitative data for a category whose values are not related to each other in any particular order, such as regions, or when the order is not based on a numeric scale. Examples would be a list of students displayed alphabetically or the top 10 sales representatives in descending order by sales. Note that SAS Visual Analytics 6.2 adds the ability to rank your data to achieve a top and bottom N graph or table. In addition, you can display bars horizontally or vertically. Horizontal bars are preferred if the category labels are long, because more space can be allocated to the labels so that the labels do not have to be truncated, staggered or worse rotated vertically. The quantitative scale on a bar chart should always have a zero-based scale (Few, 2006). Otherwise, the relative length of the bars can be misleading. Bar charts make it easy to compare discrete category data because it's easy to compare the length of bars.

Bar charts are a good choice to represent part-to-whole relationships on dashboards as well. Pie charts are often used for this purpose because they are so familiar to everyone, and it's obvious that they convey a part-to-whole relationship (Few, 2006). However, it is difficult to compare the area of each pie slice at a glance. It is easier for decision makers to compare the length of two bars and their relative contribution when the quantitative scale is zero-based. Likewise, fitting multiple pies on a dashboard can take up more space because they are round. As in Figure 5 below, changing the scale to be a percentage helps dashboard consumers understand that the bar chart can be used to understand the contribution of each category value to the whole. You can also see part-to-whole relationships by grouping multiple bars by a second categorical data item, and choose to cluster or stack the bars. Clustered bars take up more space, but it is much easier to compare the bars that represent the parts of clustered bars than stacked bar segments as each clustered bar has a base at zero. Most business users ask for pie charts on their dashboards because they are so familiar, but try to use a bar chart with a zero-based percentage axis instead for easier proportion comparison.

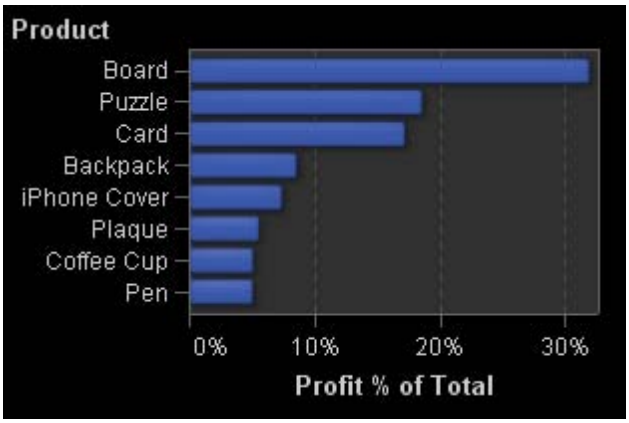


Figure 5: Horizontal Bar Showing Proportion

A dual-axis bar chart, a distinct object type in SAS Visual Analytics Designer, is a variation of the bar chart where you can have two quantitative axes and two measures, one for each axis. This is helpful if you need to display two measures having the same unit of measure and different scales, such as quantity ordered and returns, or two measures of different units of measure, such as sales and quantity ordered.

Targeted Bar Charts

A target bar chart has the same merits as the bar chart mentioned above, with the addition of a target line for each bar. You select another measure data item for the target, and the target is represented by a line that crosses the path of each bar. Dashboards measure performance, so it is often required to include target variables in your data preparation. The targeted bar chart, as in Figure 6, looks familiar to business users, and is similar to a bullet graph (covered below) without the range intervals.

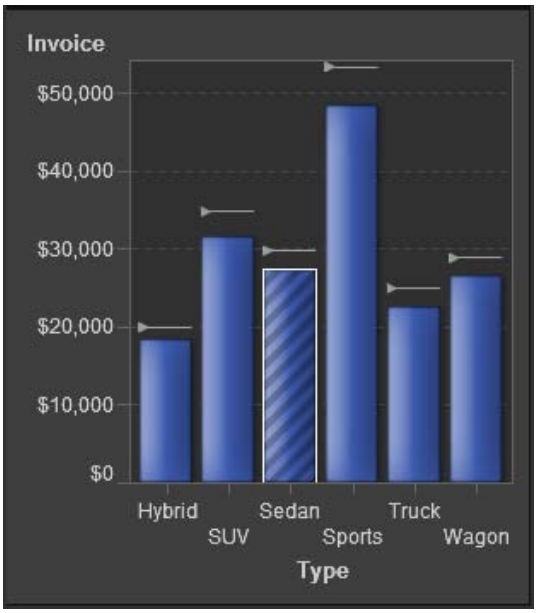


Figure 6: Targeted Bar Chart Example

Waterfall Charts

Waterfall charts show you how the value of an account balance changes over time given a series of transactions that add to or subtract from the account. They can be used for changes to other types of balances as well, such as inventory levels. The first bar in the waterfall chart represents the initial balance. Each subsequent bar begins at the ending value of the previous bar. The length and direction of a bar indicates the magnitude and type (positive or negative) of the transaction or change. The resulting chart is a stepped bar showing how incremental changes lead to the final value of the measure. You likely do not have a need for a waterfall chart in your dashboards unless you are required to emphasize both positive and negative changes to some type of measure over time.

Pie Charts

Pie charts display part-to-whole relationships on a circle divided into multiple slices for each value of a category data item based on a single measure data item. Although pie charts are familiar and might be quite popular with business users, a circle with a legend can consume more space than necessary. Further, it can be difficult to compare the area of the pie slices, especially those that have a similar contribution to the whole. For example, In Figure 7 below it would be difficult to compare the proportion of Plaque to Coffee Cup without the percentage labels, and it takes a second or two to determine which pie slice matches which product color in the legend.

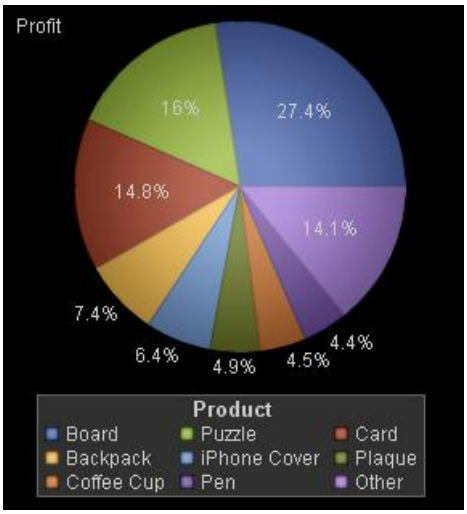


Figure 7: Pie Chart with Percentage Labels

The advantage of pies is that most business users will know immediately that your intention is to show them the contribution to a whole (Few, 2007), however, consider a bar chart using a zero-based quantitative axis with a percentage of total derived measure data item. In SAS Visual Analytics Designer 6.2, simply right-click on a measure data item in the left hand data pane and choose Derive Percent of Total from the context menu. Then assign the derived measure to the bar.

Figure 8 below is another pie chart example taken from the SAS Visual Analytics 6.1 User's Guide. Notice how challenging it is to compare the contribution of similarly sized pie slices. What if you needed to list the 6 automobile types in order by contribution? This is easy to determine on a bar chart sorted descending by contribution because of the ordered list of automobile types would be obvious. On the pie chart, the legend is sorted by contribution, but it's not as easy to determine when there are two rows on the legend, as in the example below. In addition, labeling pies with values or percentages can be difficult with limited space. It can be challenging to see the percentages and measure values in Figure 8 below that appear inside the pie for certain color pie slices. If you must use a pie, you could place the legend to the left or right to improve the likelihood that you will get a single column of descending category values so that it is easier to see the 6 automobile types ordered top to bottom. Likewise, try to limit the number of slices to 5 or 6. In SAS Visual Analytics Designer 6.2, you can use the top N ranking with All Other option to reduce the number of slices on a pie chart.

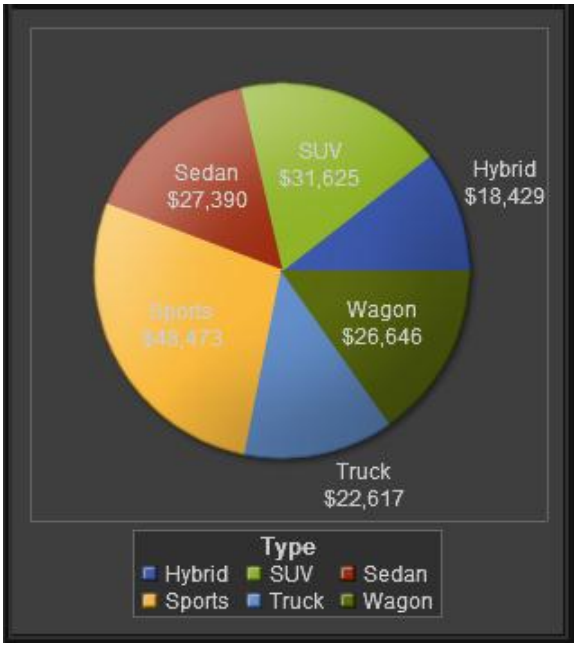


Figure 8: Pie Chart with Similar Proportions

For more information about the use of pie charts, you can read Stephen Few's article, "Save the Pies for Desert."

Line Charts

In SAS Visual Analytics Designer, there are two types of charts that display a line, which are the line chart and the time series plot. Graphs that display lines should be used only to display measures (dependent variables) along a scale of ordered quantitative items, such as time, age bands, and so on. What's different about the time series plot and line chart in Figure 9 below?

Figure 9: Comparing the Time Series Plot with the Line Chart

Although you might not notice it initially, there is a filter excluding April 2011 from both graphs. Because the line chart's x axis is discrete, you can see that April 2011 does not exist on the x axis of the line chart where the x axis on the time series plot shows equivalent sized intervals even with April missing. Therefore, the slope of the line is different between the two object types between March and May.

A line chart object is used to display one or more measures over some interval, such as time or a series of ranges. You can measure a single measure (univariate analysis) or you can understand relationships between multiple measures (multivariate analysis), such as the leading the lagging relationship between advertising and sales over time. The category on the x axis of a line chart is discrete where the category for the x axis on the time series plot (next sub-section) is continuous.

It's a common mistake to see dashboards and reports with categorical values on a line chart that are not based on dates, time, or some other interval. For example, you might see a line chart with products assigned to the x axis. Figure 10 below illustrates an example of this mistake. A relationship does not exist between the products, so there is no point in connecting the endpoints to form a line between the values for each product. Even if you ordered the products in descending order by sales to create a meaningful order, you would not want to use a line chart because the products are still independent. The slope of the line between the adjacent products, even in this order, is meaningless. Fortunately, the time series plot requires a date time data item assigned to the continuous x axis. However, you don't want to make this mistaking using the separate line chart object that allows any category to be assigned to its discrete x axis.

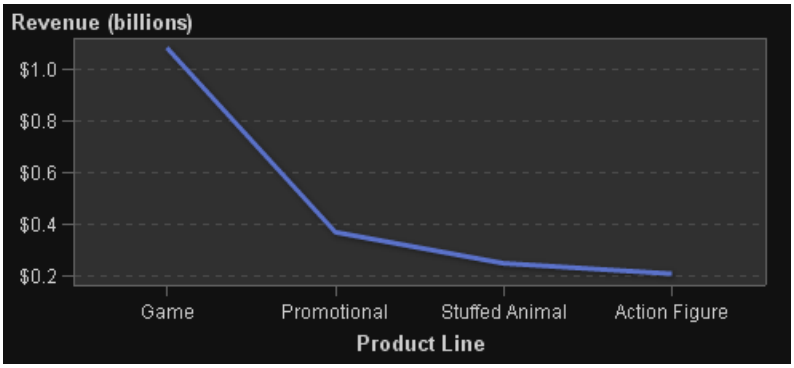


Figure 10: Poor Use of a Line Chart

Figure 11 below is a line chart object created in SAS Visual Analytics Designer. Note that this is not the default style of the line chart, but you can set frame and text styling from the style tab on the right pane to achieve this line chart appearance. This particular style was created to emphasize the data and deemphasize the supporting features, such as axis lines and tick marks. On dashboards especially, the viewer needs to interpret the shape of the data as fast as possible, rather than spend time studying precise values for unit yield for a particular unit age. This example meets that purpose. You can see that there is a sharp drop off in average yield once the age or a piece of machinery is older than 7 years.

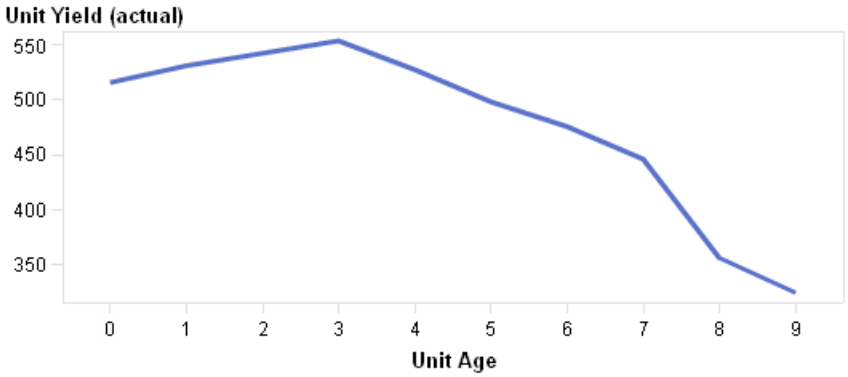


Figure 11: Line Chart Example

The dual-axis line chart is a variation of the line chart and a separate object type in SAS Visual Analytics Designer where you can look at the relationship between two measures on two different scales.

Time Series Plots

Time series plots show you an ordered sequence of values at equally spaced time intervals. If you need to show a trend on your dashboard, which is quite common, you should consider using a time series plot rather than a line chart, because the x axis is continuous. A continuous x axis is automatically ordered correctly and shows proper proportions between the x values. For example, 2010 would be 10 times the distance form 2000 than 2001 would be from 2000. The discrete axis of the line chart does not display a value for a missing date or time. (See previous section.) However, if your primary purpose is to be able to emphasize or compare the measure values for the time periods and the trend is secondary, then a bar chart would a better alternative (Few, 2006). Note that date/time on a bar chart is discrete as well, so missing items would be skipped.

A dual axis time series plot is a distinct object type in SAS Visual Analytics Designer. It is a variation of the time series plot where you can have two quantitative axes and two measures, one for each axis. This would be valuable when need to display two measures having the same unit of measure and different scales, such as quantity ordered and returns, or two measures of different units of measure, such as sales and quantity ordered. Without this object type, you would have to use more dashboard space creating two separate time series plots.

Treemaps

A treemap is divided into adjacent rectangles of various sizes that fill the entire area of the object. The color of each rectangle is determined by the value of one measure and the size of each rectangle is determined by the value of another measure. Refer to Figure 12 for an example.

Treemaps were invented by Ben Shneiderman to display a large number of category values that might be hierarchical in a relatively small amount of space so that it is easy to spot even small changes or exceptions quickly. However, treemaps are not as useful as bar charts when you need to precisely compare a measure for different categorical values. You likely would not include a treemap in a strategic dashboard for executives, where it might be appropriate for a tactical or operational dashboard where managers that are monitoring a specific business process must spot changes or problems and take action quickly. For example, you might notice all of a sudden that one rectangle is red out of a group of normally blue rectangles from the same region. It would not be uncommon for the treemap to be the only object, or one of few, on a dashboard used to monitor a larger quantity of data.

Note that the arrangement of the rectangles in the treemap is dependent on the size of the display area and changes as you resize the treemap object in your dashboard.

Figure 12: Treemap Example

Gauges

In SAS Visual Analytics Designer, gauges display the value of a primary measure compared to a target measure and quantitative range intervals to determine the primary measure's quality or status. Gauges and meters evolved in BI dashboards as an attempt to appear familiar to real objects in everyday life. Objects that you use to monitor the operation of things that you use daily, such as your automobile, home appliances, a radio, and other equipment. Perhaps there is some merit in appearing familiar, especially on initial use. However, some gauges or their optional

settings are unnecessarily real, and others are more effective for BI dashboards.

Qualitative ranges are required on all gauge types within SAS Visual Analytics Designer, and they are the primary way for you to understand whether a dashboard metric requires attention. Display Rules enable you to define range intervals along with associated background colors for a single gauge or as a shared rule across multiple gauges within your dashboard style report. You can populate the interval endpoints manually or have them generated for you at design time automatically based on the range of actual data at that time. A popup color chooser includes 9 varying intensities of 9 standard colors, and you have an option to enter a custom color code. Figure 13 illustrates the range display rule editor.

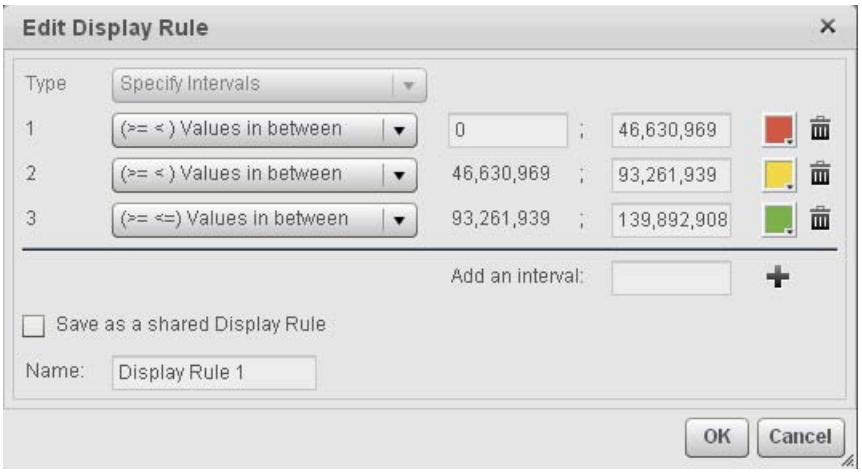


Figure 13: Editing a Display Rule with Range Intervals

The following gives you a definition and some usage guidelines for the gauges and meters available in SAS Visual Analytics Designer.

Bullet

The bullet graph was invented specifically for dashboards by Stephen Few, visualization expert, consultant, and author, as a better alternative to the gauges that you typically see on most early dashboards, such as speedometers and dials. As mentioned earlier, perhaps the automobile dashboard metaphor has been taken too literally. The bullet graph's rectangular shape helps conserve precious space on the dashboard canvas compared to round gauge alternatives, and its linear scale makes it easier to understand. You can easily see not only whether a metric is good, satisfactory or poor, the length of the bullet bar extending into the range makes it easy to see how good (2006, Few). Note that the scale for a bullet graph often begins at zero, but can contain both positive and negative values if both apply to the primary measure, such as profit. The bar inset representing the primary measure should always begin at zero so that comparing multiple bullet graphs is not deceiving.

The following specification for Stephen Few's bullet graph, in Figure 14, is from the article "Bullet Graph Design Specification," last revised March 12, 2010 (http://www.perceptualedge.com/articles/misc/Bullet_Graph_Design_Spec.pdf), and it can be found in Stephen's book, Information Dashboard Design, on page 126.

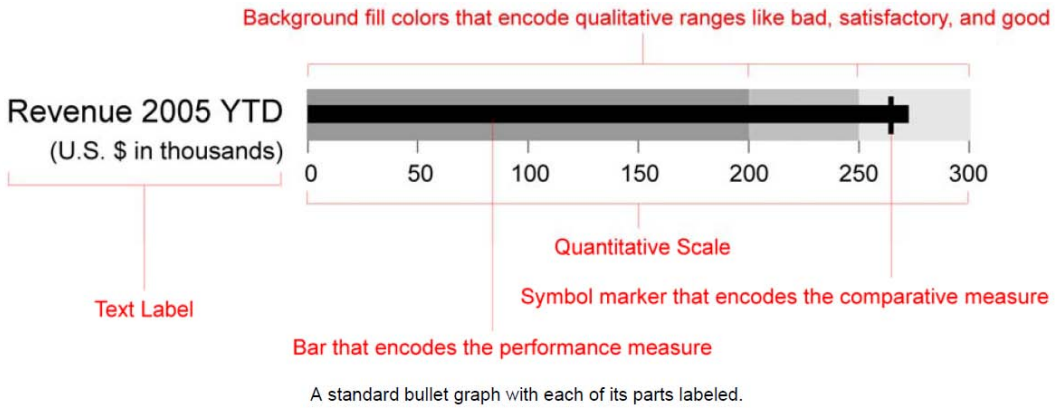


Figure 14: Stephen Few's Bullet Graph Design Specification

In SAS Visual Analytics Designer, the bullet object requires a primary measure and a range display rule, where a target measure is optional. The default orientation for the bullet is horizontal with an option to display the rectangular bullet graph vertically. All gauges in SAS Visual Analytics Designer have a style setting called KPI skin. If you choose none for this KPI skin setting, you get the closest out-of-the-box look to Stephen's original specification. Although the default background color is dark, you can change the background color (requires SAS Visual Analytics 6.2) of the dashboard to a lighter color as well as change the text labels to get closer to Stephen's specification. The following bullet graphs, in Figure 15, were created in SAS Visual Analytics Designer. You will notice the inset bar is not quite as thick as the specification above. The first example shows a bullet with a KPI skin set to none and the display rule defines three ranges having the stoplight red, yellow, and green coloring that is so typical on dashboards. Consider using a variation in saturation for a single hue, so that color blind individuals can distinguish between the green and red ranges (Few, 2006).

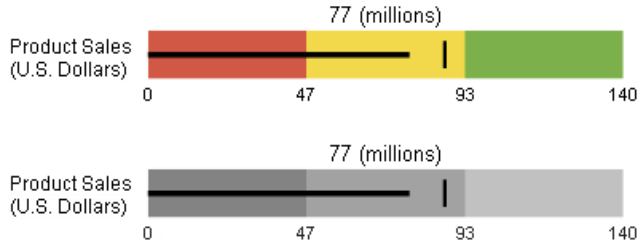


Figure 15: Two Bullet Gauges with Different Range Colors

For the current release, bullet graphs work best when the measure results in a positive number. SAS Visual Analytics always starts the inset bar at the leftmost edge, rather than at zero on the scale. It's typical for bullet graphs to have a scale starting at zero, but you might have a measure that could result in a positive or negative value, such as profit. Therefore, you might try to set your first range to begin at a negative number and the final range ending with a positive number to accommodate potential for both positive and negative results. However, rather than staring at zero and growing left, the inset bar starts from the far left and grow right up to the negative number. Therefore, if you need to show negative values on a gauge, you should consider using a slider instead.

Slider

A slider is similar to a bullet graph in that it shows a primary measure value, a series of range intervals, and an optional target value in a rectangular space. Like a bullet graph, a slider is oriented horizontally by default, and you can change the orientation to vertical. However, the difference is in how the primary measure and target are represented.

Figure 16: Slider Gauge

So when would you use a slider and when would you use a bullet graph? If your quantitative scale starts at zero, it is best to use a bullet graph. However, if your quantitative scale begins with a value greater than or less than zero, a bullet on the gauge to represent the primary measure would be misleading when comparing to multiple bullet graphs with the same scale. If this were the case, the length of one bullet might be half as long as another bullet, but the value would not be half as much. In SAS Visual Analytics Designer, a bullet graph always has an inset bar in the middle for the primary measure. (See previous section.) Therefore, you should use a slider when the numeric scale does not start at zero. Figure 16 above shows an example slider where the scale begins at 5. The average price is the primary measure represented by the value 21 and the green triangular needle pointing down, where the target is represented by the smaller black triangle pointing upward. The line along the center of a bullet graphs is easy to interpret, so consider using a quantitative scale starting at zero if appropriate, so that you can use a bullet graph whenever possible.

Thermometer

The thermometer is a gauge similar to the slider and bullet in that it requires a primary measure value and a range-based display rule. A target measure is optional on the thermometer, just like the other two. However, the thermometer differs from the slider and bullet in that only the color associated with the range interval that includes the value of the primary measure is used to color the thermometer from its base to the endpoint of the primary measure value. You would not see multiple colors on a thermometer. Essentially, a thermometer is a bar where the entire bar is colored conditionally based on one color from the display rule.

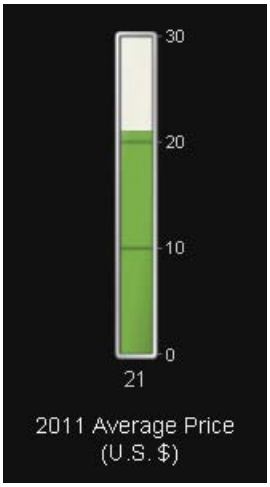


Figure 17: Thermometer Gauge

There are pros and cons to this approach. If three colors on every object in your dashboard is the norm, then how can color help you spot the exceptions? With the thermometer, you can easily spot the qualitative value at a glance for the primary measure without also seeing the possible colors of other ranges. This can be even quite helpful when there are multiple thermometers. For example, If the dashboard screen were full of thermometers, you can quickly spot the metrics that are red and requiring attention. Rather than every gauge having a portion of its scale being red, only the thermometers where the primary measure's value is within the red range would display any red.

However, there is a downside to the thermometer gauge as well. The color of the range that is farthest away from zero on the quantitative scale would be more prominent on the thermometer than the colors for ranges closer to zero because the length of the colored bar would be longer. For example, if you have a range from zero to 10 as red, 11 to 20 as yellow, and 21 to 30 as green, a value of 21 would be easier to see as green than a value of 2 would be to see as red. In fact, it might be quite difficult to detect red at all for a primary measure value close to zero in this example. Figure 17 shows a thermometer with a prominent green bar because the average price for 2011 is $21 is between 20 and 30.

The base on a thermometer bar (green portion above) should always start at zero. In SAS Visual Analytics Designer, you accomplish this by defining your first range display rule beginning at zero. SAS Visual Analytics always shows the base of the bar at the bottom of a thermometer, just like a real thermometer. Perhaps familiar to those of you that have used classic thermometers rather than digital thermometers. However, measuring negative values can be difficult to quickly understand, even on a real thermometer, and comparing multiple thermometers with a base starting at a negative number can be misleading. Therefore, a thermometer object is not the best object type for measures that might have negative values, such as profit.

Dial

The dial is a type of gauge typically seen on dashboards. The dial requires a primary measure and a range-based display rule with the option for a target measure. The value of the primary measure is represented by the triangle or arrow extending out from the center circle, and the target value is represented by an arrow pointing inward from the outer arc.

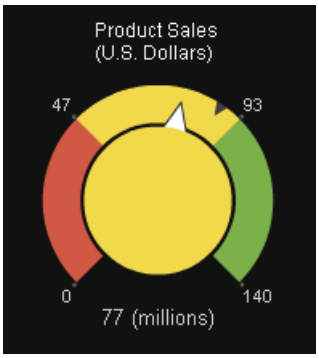


Figure 18: Dial Gauge

However, the dial is not the same, and you should consider the bullet or one of the other rectangular gauges instead. The most noticeable difference between the dial and the three previous gauge types is the dial's arc shape, which makes the dial require more space than the three rectangular gauge types. Another significant difference is the color of the center circle is the color associated the primary measures value's range interval. This can make the qualitative state of the measure more prominent, somewhat like the thermometer. Unlike the thermometer, however, all range intervals and their associated colors are still visible. This overcomes one of the limitations mentioned for the thermometer where a range closer to zero would not be as prominent as a range farther away from zero. The greatest challenge with a dial gauge type is that it consumes more screen real estate on your dashboard than the rectangular alternatives. It can also be more difficult to compare the measure value of multiple adjacent dials because the quantitative scale is not linear.

Speedometer

Last but certainly not least seen on typical BI dashboards is the gauge type that you likely think of first when you hear the word dashboard used in the context of an automobile, the speedometer. Much like the dial above, speedometers are circular with an arc shaped quantitative scale. They too require a primary measure as well as a range display rule, and the target measure is optional. The value of the primary measure is represented by a needle extending from the center, and the optional target is represented by a small triangle along the quantitative scale either point inward or outward depending on the KPI skin setting for the gauge. Figure 19 shows two built in styles for the speedometer, KPI skins none and satin. Other skin settings are basic, charcoal, modern, and onyx. The display rule ranges in the examples show stoplight red, yellow and green that you see too often on BI dashboards, though you can and should consider a single color with different intensity for each range.

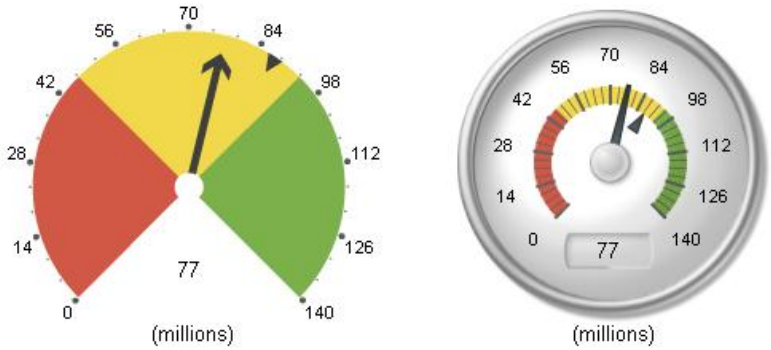


Figure 19: Two Speedometer Gauges with Different Skins

Although speedometers might be familiar to most everyone, they are the least effective gauge type. Not only do they consume more dashboard space than their rectangular alternatives, their non-linear scale make the primary measure more difficult to compare to other speedometers on the dashboard having the same scale than a gauge with a linear

scale. Instead, consider using a bullet if your scale can begin at zero or a slider if your measure could be positive or negative. If you want to narrow the scale to exclude zero to zoom in on the primary measure values, a slider would be the best option.

GEOGRAPHICAL MAPS

Data often contains location attributes, such as addresses of your customers, locations of stores and facilities, and the places business transactions or events happen. Geographic maps are specialized display options, and when included in your reports and dashboards, they can enable you to see spatial relationships that would be difficult to see in a table or bar chart. For example, you might be able to spot an abnormal situation faster on a map when one store location out of several in a particular city on a given day has a much lower or higher sales volume than other stores in the same city. Perhaps the store does not have enough employees scheduled or road construction could be preventing customers from being able to get to the store easily. Regardless, this condition might be more difficult to spot on a bar chart even when it's sorted by sales volume. Geographical maps can be valuable to include in dashboard-style reports only where spatial relationships help see patterns that would be difficult using other object types.

Like a treemap, however, geographic maps usually require a significant portion of screen real estate. If the spatial relationship is not important for your dashboards purpose, use another object type instead. However, if you really need to display a geographical map to show spatial relationships, and you cannot fit all other required metrics and information on the same screen without scrolling, you can use the geographic map as your starting point for navigation to one or more other dashboards and detailed reports passing the location information do the target as a filter. It can be quite valuable to display other display types alongside a geographic map so that you can see spatial relationships at the same time as other relationships. You can create a filter or brush interaction relationship between your geographical map and the other objects on your dashboards. Therefore, when you click on a specific region or city, the other objects filters or highlights to show the same location.

In SAS Visual Analytics Designer 6.1, you can add a geographical map to your dashboard-style reports. It displays your data as a bubble plot that is overlaid on a geographic map. Each bubble is located at a geographic location or at the center of a geographical area, such as a country. The circles or bubbles are automatically colored by the location, and you provide a measure data item that determines the size of the bubbles. Note that a geo map requires a data item in with a role type of geography. In SAS Visual Analytics Designer 6.1, if you change a category data item, for example, country, to a role type of geography, you are prompted to select the data items from the same source table that represent latitude and longitude for that country. Figure 20 illustrates an example of a geographic map created in SAS Visual Analytics Designer 6.1 showing a measure as bubbles for different manufacturing facilities in the United States.

Figure 20: Geographical Map in SAS Visual Analytics Designer

SAS Visual Analytics Designer 6.2 enhances the geographical maps in two ways. First, you have the ability to display choropleth maps on your dashboards. With this option, you can fill with color geographical boundaries on a map, such as a country or province, based on measure values aggregated to the level defined by geographical boundary. If your dashboard does not need to measure a particular location, such as a store or company facility and you want to emphasize a larger area, the color on a choropleth map is more noticeable. Second, administrators can establish a reference to an external file that contains the latitude and longitude values for each location so that the source table does not have to include columns for latitude and longitude. Likewise, you won't be required to manually reference the separate latitude and longitude attributes while building your dashboard, though you still can. These enhancements for SAS Visual Analytics Designer 6.2 are anticipated to be available summer 2013.

GRAPH LATTICES FOR EASIER COMPARISON

Dashboard screen real estate is quite limited, so it is tempting to cram as many lines or bars, for example, on a single graph to preserve space. However, if it's too difficult to compare the values, then its value is limited. In these cases, it would be easier to compare the bars, lines, and gauges if you break the graph up into multiple instances, one for each region for example, having the same scale and other graph characteristics. This way of organizing the information has been referred to by Edward Tufte as "small multiples," and has been referred to as a lattice, trellis, and matrix of charts as well (Tufte, 2001).

SAS Visual Analytics Designer provides additional grouping data item roles on most graphs and gauge types that enable you to display multiple instances either vertically, horizontally, or both to form a matrix. On bars and lines, these optional category data item roles are referred to as lattice columns and lattice rows. For gauges, the optional role called group determines which category data item is used to create multiple instances of the gauge. Figure 21 on the next page illustrates two examples of "small multiples" to facilitate comparison.

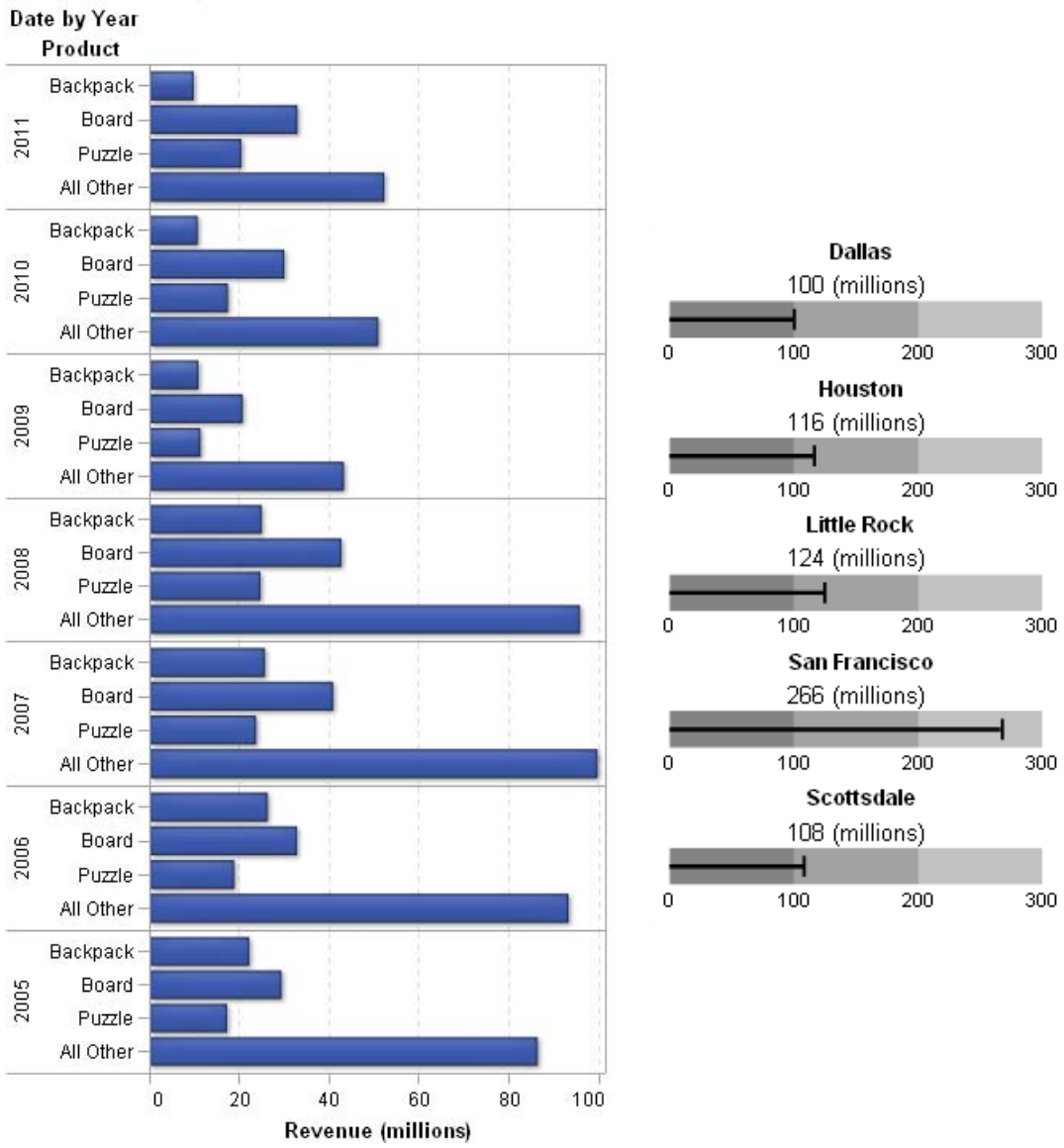


Figure 21: Bar with Lattice Rows and a Grouped Bullet

TOP & BOTTOM RANKINGS

With SAS Visual Analytics Designer 6.2 you can rank your data to show the top or bottom values for a category based on a measure. Because dashboard-style reports are for monitoring at a glance and should fit on a single screen, you likely do not have enough space to include all of your locations, sales employees, products, and so on. You can simply right-click on your graphs and tables to add a ranking to limit the number of bars, rows, and so on, to a top or bottom N, with an option to display an All Other value to see the measurement for the categories that did not qualify as top or bottom N. Figure 22 below shows a bar chart with top 5 products and an “All Other” bar. With “All Other” displayed on tables and crosstabs, your totals and subtotals and percentage of totals and subtotals display a value with respect to all category values without having to actually display them all.

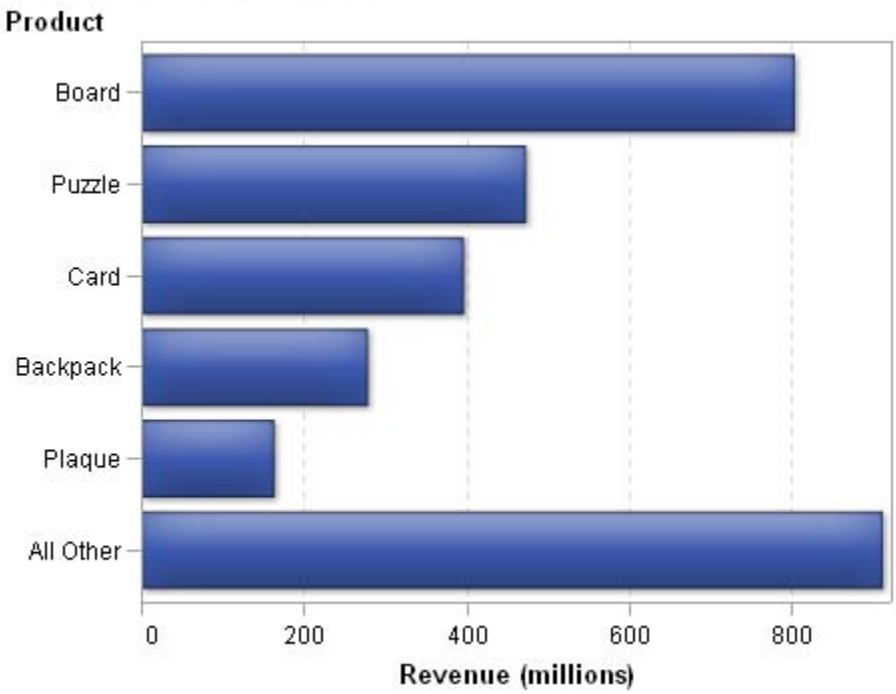


Figure 22: Top 5 Bar with "All Other"

DASHBOARD INTERACTIONS

Filter or Brush between Visuals

You can interact with SAS Visual Analytics dashboards from your web browser or tablet to see relationships in your data. As a dashboard author, SAS Visual Analytics Designer gives you the ability to create associations between dashboard objects that allow consumers to interactively narrow their focus across all visuals on the screen simultaneously. In order to enable interactions, you can switch to the interactions view and drag your mouse between two or multiple objects sharing a common data source to establish either a filter or brush relationship. Brushing allows viewers to highlight portions of your dashboard across multiple graphs and tables at the same time. Brushing occurs when a dashboard viewer clicks a portion of one dashboard object, such as a bar on a graph, and one or more other graphs and tables highlight the same category values or portions in other views. Similarly, an interactive filter is initiated the same way. However, the associated objects would remove all information except the category values selected on the first object. Note that filter relationships happen in one direction, so you create a parent child relationship between dashboard objects. This works well for one to many relationships in your data, such as a bar of regions associated with a table of city details. Brush relationships are bi-directional and work well when you have a many to many relationship between the information displayed, such as regions associated with products. Interactive dashboards help you narrow your focus across multiple views in one simple operation.

Filter Controls

You can provide controls, such as drop down list and date range calendars, anywhere on your dashboard to help managers narrow their focus to progressively more specific information. In SAS Visual Analytics Designer, you can drag and drop drop-down list, button bar, and text input controls to an area at the top of the dashboard that will filter all data objects in the dashboard. Similarly, you can drag and drop all filter control types anywhere onto the dashboard and use the interactions view to make filter or brush associations with other filter controls, tables, and graphs. Table 1on the next pages shows an example of each filter control in SAS Visual Analytics Designer.

Icon	Control Type	Example
	Drop-down List	
	List	
	Button Bar	
	Text Input	
	Range Slider	

Table 1: Available Filter Controls

LINKING TO MORE INFORMATION

Like the home page of a well-designed website, a dashboard should serve as a starting point for more information when needed. SAS Visual Analytics Designer 6.2 enables you to establish links from tables and graphs on your dashboard to other sections (tabs) within the same dashboard, another dashboard, or a more detailed report created in SAS Visual Analytics Designer. Like filter interactions covered previously, you can link to other sections in your dashboard from the interactions view by dragging association links from specific tables and graphs to other sections. When you are viewing the dashboard from your web browser or tablet, clicking on a single bar, row or column, and so on, navigates you to a different section of information passing all filter context from the original section in order to filter the views based on the same data source in the target section. When you link to a separate dashboard or report, the filter context is automatically passed as well to the tables, graphs and gauges in the target report based on the same data source. Note that you can establish multiple link targets for a dashboard object, and you are given a choice of multiple targets when initiating a link operation while viewing the starting dashboard. Linking multiple

dashboards and reports together gives you a way to layer the information for the intended users, guiding them down a progressively narrower path to relevant details.

DASHBOARDS TO GO WITH SAS MOBILE BI

There is no doubt that mobile devices, specifically tablets and smartphones, have gone mainstream in both the consumer and business world, but will mobile BI be adopted broadly too? Most executives, decision managers, and frontline workers spend little time at a desk examining a traditional monitor. They spend significantly more time in conference rooms, traveling, in stores, on the shop floor, and so on. Where and when do you think they make most decisions? Not likely often in solitude at their desk, and not always between 8am and 5pm. Many decisions or actions involve a decision making process, formal or informal, that requires collaboration and approval. Most folks involved in the decision making process just need a few key metrics quickly to inform their process. Mobile BI removes bottlenecks that occur when key stakeholders must wait until they return to their desks before responding with recommendations, decisions, and actions with confidence.

Mobile BI capabilities have been available to SAS Enterprise BI Server customers for about two years when you purchase separately Roambi™ ES for SAS. Integration between SAS and Roambi is accomplished through a MeLLmo-developed adapter. With this add-on to SAS Enterprise BI Server, you can publish data from a SAS Web Report Studio report to create a Roambi view for viewing on Apple iPhones and iPads.

With the release of SAS® Mobile BI in 2012, decision makers and stakeholders at various levels can more quickly and easily access relevant information on their iPads or Android tablets. You can view your dashboards and reports securely either online or offline. The native mobile applications, available for download from Apple's iTunes store and GooglePlay, make dashboards as well as detail reports interactive using familiar device specific UI elements and gestures, such as pinch zooming and swiping. You can drill down hierarchies for more information at the next level. Link indicators enable you to select an item on one visual that is applied as a filter or selection across other visuals simultaneously. You can add comments via text, video, and audio to collaborate as well. SAS Mobile BI already lets you view dashboards and reports created in SAS Visual Analytics Designer. With SAS Mobile BI, relevant information is always available helping remove delays.

BI on mobile devices can raise questions from IT folks responsible for security. SAS Mobile BI gives your IT organization a mobile tethering option, allowing your administrators to control which users or user groups can access reports while offline. In addition, support for enterprise security, including VPN, SLL, HTTPS, black listing, and remote wipe capabilities. Although information can be delivered more broadly via mobile devices, IT still maintains control of the underlying data and security with SAS Mobile BI.

SAS Visual Analytics 6.2 and the follow-on update to the SAS Mobile BI applications is anticipated summery 2013. With these new releases, you can also link from a dashboard object to other sections within the same or different dashboards while passing selections as filters to the target views. With the upcoming SAS Mobile BI release, you can annotate screen captures of reports, and then e-mail them to others. In addition, you can view reports created in Web Report Studio as well if you are an Enterprise BI Server customer. Administrators can require a passcode for the SAS Mobile BI applications as well as set session timeouts. The upcoming releases of SAS Visual Analytics and SAS Mobile BI will have a number of enhancements to improve your user experience.

For more information about SAS Mobile BI, please refer to SAS Global Forum 2013 paper 053-2013, "How Mobile Changes the BI Experience," Murali Nori. Figure 23 below illustrates the SAS Mobile BI iPad application where users can see the reports that they have subscribed to.

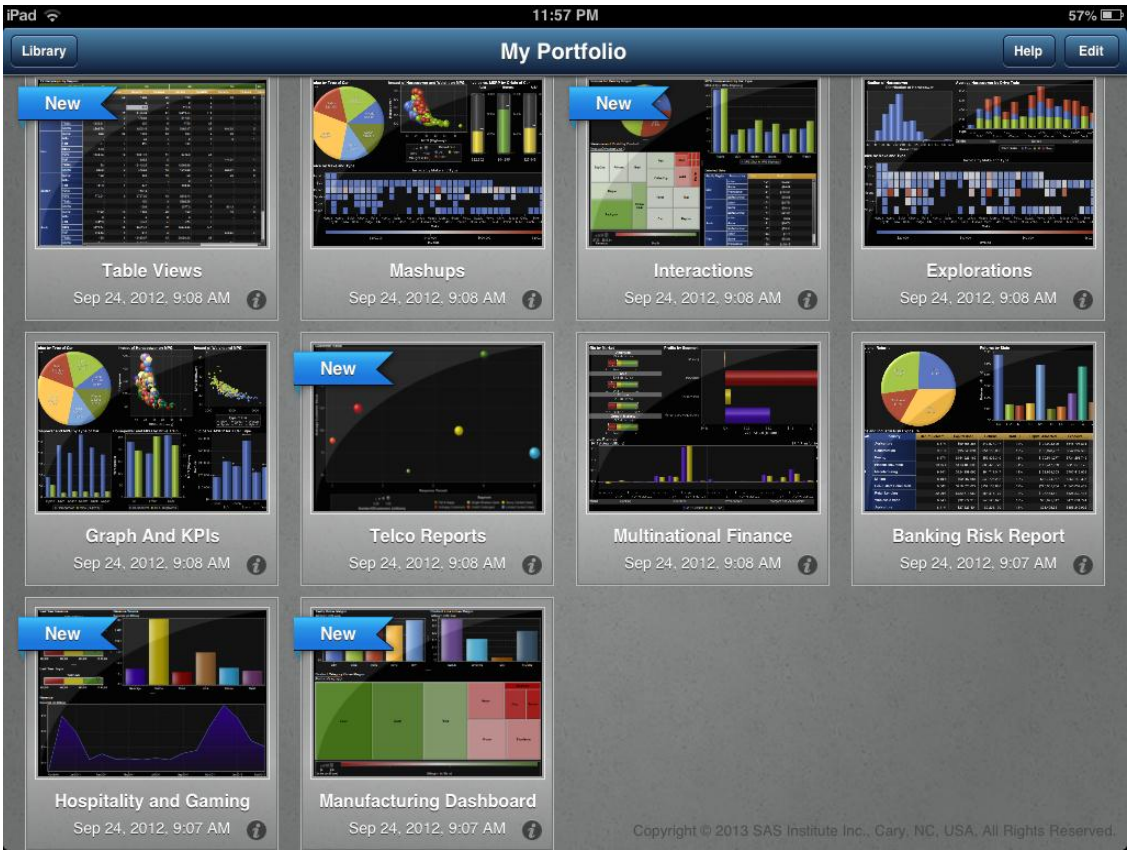


Figure 23: SAS Mobile BI My Portfolio

CONCLUSION

Most organizations these days are using BI dashboards in some form or another to improve their ability to use information in support of decisions at multiple levels. Research shows that organizations are planning to increase their use of dashboards and that dashboard projects have been considered successful. SAS Visual Analytics is designed to enable both ad hoc visual data exploration as well as publication of highly formatted dashboards style reports. The SAS LASR Analytic server is a key in-memory technology enabling unprecedented speed when exploring large volumes of data and interacting with published dashboards. SAS Visual Analytics Designer provides you a number of object types and layout control in order to create interactive dashboards that can link to additional reports maintaining context. Understanding which objects to use on your dashboards for specific information monitoring needs of individuals is a key design skill required to ensure that your dashboards are used. SAS Mobile BI provides secure and interactive access to published dashboards and reports on your iPad or Android tablet, so that everyone involved in collaborative decision making can stay productive. SAS Visual Analytics makes well designed dashboards fast, collaborative and effective.

REFERENCES

Few, Stephen. 2006. *Information Dashboard Design: The Effective Visual Communication of Data.* Sebastopol, CA: O'Reilly Media, Inc.

Few, Stephen. 2004. "Dashboard Confusion," Intelligent Enterprise. Published March 20, 204 - http://www.perceptualedge.com/articles/ie/dashboard_confusion.pdf

Howson, Cindi. 2012. "2012 Successful BI Survey: Best Practices in Business Intelligence for Greater Business Impact." BI Scorecard - https://www.biscorecard.com/businessintelligenceevaluations.asp#spclrept

Tufte, Edward R. 2001. *The Visual Display of Quantitative Information, 2nd Edition*. Cheshire, Connecticut: Graphics Press.

Few, Stephen. 2007. "Save the Pies for Desert." Perceptual Edge - http://www.perceptualedge.com/articles/08-21-07.pdf

Few, Stephen. Revised March 12, 2010. "Bullet Graph Design Specification." Perceptual Edge - http://www.perceptualedge.com/articles/misc/Bullet_Graph_Design_Spec.pdf

SAS Institute Inc. 2012. *SAS® Visual Analytics Users Guide.* Cary, NC: SAS Institute. http://support.sas.com/documentation/onlinedoc/va/index.html

SAS Institute Inc. 2012. *SAS® LASR™ Analytic Server 1.7Administration Guide, Second Edition SAS.* Cary, NC: SAS Institute.

SAS Institute Inc. 2006. *Implementing Dashboard Samples with SAS*. Cary, NC: SAS Publishing - http://support.sas.com/rnd/datavisualization/yourGraphs/dashboards/grdbrd.pdf

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RECOMMENDED READING

- SAS Institute Inc. 2012. "What's new with in-memory computing?," with Oliver Schabenberger and Alison Bolen. SAS Voices - http://blogs.sas.com/content/sascom/2012/04/18/whats-new-with-in-memory-computing/
- Howson, Cindi. 2007. *Successful Business Intelligence, Secrets to Making BI a Killer App*. New York, NY: McGraw-Hill Osborne Media
- Rasmussen, Nils, Chen, Claire Y, and Bansal, Manish. 2009. *Business Dashboards, A visual Catalog for Design and Deployment*. Hoboken, NJ: John Wiley & Sons, Inc.
- Nori, Murali. 2013. Paper 053-2013, "How Mobile Changes the BI Experience." SAS Global Forum
- Chitale, Anand and Redpath, Christopher. 2013. 057-2013 "Whirlwind Tour Around SAS® Visual Analytics." SAS Global Forum
- Trivedi, Bharat and Lycan, Christiana. 2013. Paper 050-2013 "Linking Strategy Data in BI Applications." SAS Global Forum
- Simien, Christopher. 2010. *The Design of Information Dashboards Using SAS®*. CreateSpace Independent Publishing Platform
- SAS Institute Inc. "SAS/GRAPH Dashboard Samples" - http://support.sas.com/rnd/datavisualization/yourGraphs/dashboards

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