



## A Guide to Creating Dashboards People Love to Use

To get a Designing Dashboards Poster, go to:  
<http://www.juiceanalytics.com/poster/>

# Dashboard Design Matters

Dashboards have become a standard business tool over the last decade. Dozens of dashboard building solutions have sprung up to meet the demand. Yet in the flurry of technology and enthusiasm, little attention has been paid to how to design focused, thoughtful, and user-friendly dashboards. Our three-part guide will show you the concepts and give you the best practices to create a high-impact dashboard that people love to use.

Traditional dashboard design focuses almost exclusively on defining the right success metrics, then piecing together a bunch of charts and gauges on a single page. These techniques yield dashboards with a hodgepodge appearance and confusing information.



*Traditional dashboard design techniques result in confused solutions*



*This guide will help you design more intuitive and effective dashboards*

In the early days of the world wide web, it was good enough to simply have the right information on the web page. The current industry-standard dashboards are no more ambitious. However, modern web design has moved on to seek a union of utility, usability and beauty. We must find a similar union when displaying data in business.

This document approaches dashboard design in a holistic way, beginning with general goals and evolving to specific data presentation. *Part 1: Foundation* helps you identify your target audience, understand what type of dashboard you want to create and why it is valuable to your organization. It concludes guidance regarding how to focus your message

on the information and metrics that matter. *Part 2: Structure* helps you start on designing your dashboard, including what form it should take, how to design for audience understanding, and what navigation, interactions, and capabilities will make your dashboard useful and engaging. Finally, *Part 3: Information Design* dives into the details of interface and information design. You will learn how to lay out your dashboard and best practices for charting and data presentation.

# Part 1: Foundation

## A Purpose-Filled Dashboard

We've all heard reasons why business dashboards are useful: that which we measure we improve, and the importance of a shared understanding of the state of your business.

You need to find the specific reasons why *your dashboard* will be useful to *your organization*. This section offers exercises to define and refine the purpose for your dashboard. With this purpose in mind, the real work of creating a dashboard will come more easily. Better yet, you will have a standard against which you can evaluate success. There are three key questions:

1. Who is my audience?
2. What value will the dashboard add?
3. What type of dashboard am I creating?

### Who is my audience?

Dashboards need to start with an audience in mind. Who is the consumer of the dashboard? What are their information needs? What do they already know? What are their experiences and prejudices? As we design the dashboard, understanding the consumers of the dashboard will help us craft a product that they love to use.

A complicating factor is that most dashboards have multiple audiences. In fact, delivering the same dashboard across an entire organization has the potential benefit of getting everyone on the same page. However, a diverse audience is hard to serve well. Therefore, try to prioritize the audiences so conflicts can be more easily handled.

Here are a few of the factors to consider about your audience, and the implications for a dashboard design:

	Questions	Implication
<b>Role</b>	<p>What decisions do they make?</p> <p>What questions do they need answered?</p>	Structure the information to make it super easy to answer high priority questions.
<b>Work flow</b>	<p>In what context will they be reviewing the dashboard?</p> <p>What information are they using on a daily basis?</p> <p>How much time do they have to review the numbers?</p>	The form and information display needs to fit into an existing work flow. For example, an on-the-road sales person may need information delivered to her BlackBerry, not designed for an online wide-screen monitor.
<b>Data comfort and skills</b>	<p>How sophisticated are they with using data?</p> <p>Are they proficient in Excel?</p> <p>Do they enjoy digging into the numbers?</p>	The dashboard's level of detail and analytical capabilities should match the audiences' comfort zone.
<b>Business and data expertise</b>	<p>How familiar are they with the key performance metrics?</p> <p>Do they understand where the data comes from?</p> <p>Are they familiar with internal company or industry terminology?</p>	This determines the need for embedded explanations and use of natural language.

## What value will the dashboard bring?

Dashboards can serve many purposes. Take a moment to consider what you want to get out of your dashboard. Check the top three reasons below.

- Help management define what is important
- Educate people in the organization about the things that matter
- Set goals and expectations for specific individuals or groups
- Help executives sleep at night because they know what's going on
- Encourage specific actions in a timely manner
- Highlight exceptions and provide alerts when problems occur
- Communicate progress and success
- Provide a common interface for interacting with and analyzing important business data

## What type of dashboard am I creating?

We've seen a lot of discussion about the definition of a "dashboard." Some people argue that something only qualifies if it fits on one-page or shows real-time information or offers a comprehensive view of a business. We find those requirements too constraining.

Dashboards can come in many flavors. What never changes is good dashboards focus on the most important information and communicate this information clearly and concisely. The delivery channel, level of interactivity, timeliness of data, and analytical capabilities will vary based on the situation.

Below is a list of options for your perfect dashboard. Check the boxes that best fit your situation.

Scope	<input type="checkbox"/> <b>Broad:</b> Displaying information about the entire organization	<input type="checkbox"/> <b>Specific:</b> Focusing on a specific function, process, product, etc.		
Business role	<input type="checkbox"/> <b>Strategic:</b> Provides a high-level, broad, and long-term view of performance	<input type="checkbox"/> <b>Operational:</b> Provides a focused, near-term, and tactical view of performance		
Time horizon	<input type="checkbox"/> <b>Historical:</b> Looking backwards to track trends	<input type="checkbox"/> <b>Snapshot:</b> Showing performance at a single point in time	<input type="checkbox"/> <b>Real-time:</b> Monitoring activity as it happens	<input type="checkbox"/> <b>Predictive:</b> Using past performance to predict future performance
Customization	<input type="checkbox"/> <b>One-size-fits-all:</b> Presented as a single view for all users	<input type="checkbox"/> <b>Customizable:</b> Functionality to let users create a view that reflects their needs		
Level of detail	<input type="checkbox"/> <b>High:</b> Presenting only the most critical top-level numbers	<input type="checkbox"/> <b>Drillable:</b> Providing the ability to drill down to detailed numbers to gain more context		
Point of view	<input type="checkbox"/> <b>Prescriptive:</b> The dashboard explicitly tells the user what the data means and what to do about it	<input type="checkbox"/> <b>Exploratory:</b> User has latitude to interpret the results as they see fit		

## Information Discrimination

The single most common mistake we see in dashboard design is treating all information as if it is equally important. Amanda Cox of the New York Times design group said it perfectly: “Data isn’t like your kids, you don’t have to pretend to love them equally.”

Too often the criteria for including information in a dashboard is whether someone influential thought it might be interesting. We propose a more stringent requirement: Will the information drive productive action? Here are a few strategies to help narrow down to the information that really matters:

- ▶ **Find the core.** Your dashboard should be more than a lot of data on a screen. It should have a core theme based on the essence of the problem. A sales dashboard may be about “How can we more effectively move leads through our pipeline?” A marketing dashboard may strive to answer: “How can we optimize our marketing investments?” Finding this core will give you the logic and argument for discarding extraneous information.
- ▶ **Ask a better question.** Dashboard requirements can quickly turn into a laundry list of unrelated metrics, dimensions, and half-baked analyses. The root of this problem stems from only asking “what would you like to know?” Here’s the one follow-up question you need to narrow down the list: “What would you do if you knew this information?” This question separates the novel and whimsical desires from the important and actionable information.
- ▶ **Push to the appendix.** Sometimes it is impossible to ignore the requests for certain information to be included in the dashboard. In these cases, one option is to create an appendix report that includes the “interesting” information but keeps the focus on the most critical data. In other words, keep truly critical information on the front page and suppress ancillary information.
- ▶ **Reporting vs. exploration.** For all the things that a dashboard can be, it cannot be a generic analysis tool. It cannot be designed to slice and dice data to explore and answer a new question every time. This is a dynamic we refer to as the difference between herding cows and herding cats. When people ask for information focusing on uncharted territory, this is the domain of analysis, not your dashboard.

*“Data isn’t like your kids,  
you don’t have to pretend  
to love them equally.”*

Amanda Cox, NY Times



[www.flickr.com/photos/archeon/268660409/](http://www.flickr.com/photos/archeon/268660409/)

[www.flickr.com/photos/srcosmo/169329862/](http://www.flickr.com/photos/srcosmo/169329862/)

Reporting measures and monitors things that are well-understood and predictable

Exploration helps develop an understanding of new processes, erratic and shifting behaviors

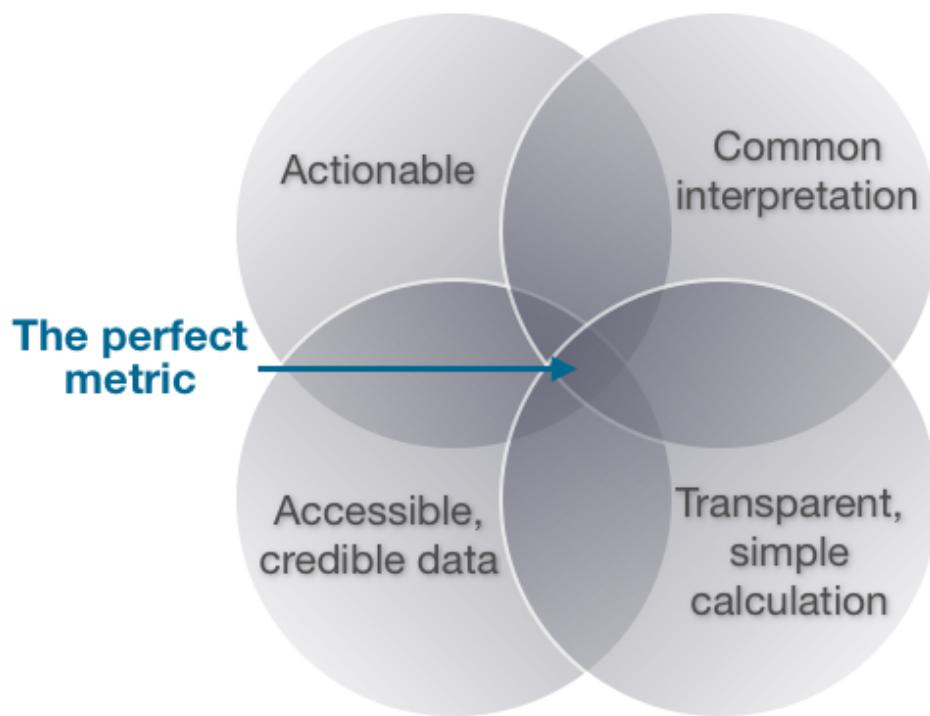
We cannot emphasize it enough—the success of your dashboard will come down to your ability to distinguish between useful, productive information and interesting but extraneous information.

*“Perfection is achieved, not when there is nothing more to add, but when there is nothing left to take away.”*

*Antoine de Saint-Exuper*

## Choosing the perfect metric

Your organization may know the exact metrics that aligned behaviors, drive strategy, and track success. For the rest of us, defining the right metrics for your dashboard is a tricky, ever-evolving task. Below is a simple framework to help hone in on the right performance metrics.



	Description	Common mistakes
<b>Actionable</b>	It is clear the source of the problem or necessary actions when the metric goes up, down, flat or off-target	It is too broad for specific groups to impact (e.g. customer satisfaction).  Focus on absolute measures rather than changes (e.g. total sales vs. change in sales)
<b>Common interpretation</b>	People in the organization recognize what the metric means	It uses data definitions that aren't well understood (e.g. leads vs. prospects).
<b>Transparent, simple calculation</b>	How the metric is generated is shared and easy to understand	Attempting to create a compound metric that combines a bunch of factors
<b>Accessible, credible data</b>	The data can be acquired with modest effort from a source that people trust.	Pursuing the perfect metric that is hard to gather rather than using a close proxy.

*A note on goals:* Metrics without goals can be a waste. Unfortunately, getting people to agree to specific targets can be painful. After all, goals start us down a slippery slope toward clear accountability. Don't give up. We've found that the first step is to simply get people to buy-in to the success metrics by creating clarity on definitions, showing trends, and incorporate them into the organization's vernacular. Eventually, people start to question why there isn't a goal set. Pretend to act surprised by the cleverness of this suggestion.

## Creating a Solid Foundation

Part 1 of our guide should help you map where you are going before you start throwing charts on a page. In this paper we've addressed these topics:

- How is the dashboard going to add value to my organization?
- What type of dashboard am I creating?
- Who is the audience of the dashboard and what are their needs?
- What is the central thought-line of my dashboard story?
- What are the key metrics that will focus users on actionable information?

If you can answer with confidence the questions we've discussed here, you will have a solid foundation before you get into the details of your dashboard design.

In Part 2, we will discuss the form and structure of your dashboard. We will help you create a frame for your dashboard that makes it easy for users to understand what they are looking at and navigate and interact with information.

# Part 2: Structure

## Framing the Dashboard

Now that we've defined in Part 1 what the dashboard should accomplish for your audience, it is time to start thinking about how your dashboard actually looks and how it works. This section offers ideas about the big-picture elements of your dashboard—the building blocks that you will use to construct the dashboard. The building blocks can be broken into four categories:

1. **Form:** In what format is the dashboard delivered?
2. **Structure:** How is the dashboard laid out to help users understand the big picture?
3. **Design principles:** What are the fundamental objectives that will guide your design decisions?
4. **Functionality:** What capabilities will the dashboard include to help users understand and interact with the information?

## Form

The conventional view has been that dashboards need to be constrained to a single page; we believe dashboards can come in many forms. A short e-mail can serve as a dashboard if it works for the recipients. Likewise, a wall-mounted 55" plasma TV showing an animated presentation has the potential to be an effective dashboard.

What's important is selecting a form that fits the need of the situation—form follows function. The function of a dashboard is to communicate critical information to your audience in a way they can understand, delivered when and where they need the information.

Before you decide how you want to deliver your dashboard, think about a few factors that may influence the dashboard form:

1. **Timeliness:** How frequently is the data in the dashboard updated?
2. **Aesthetic value:** How important is it that the dashboard look attractive, or can it be purely utilitarian?
3. **Mobility:** Does the audience need to access the information on-the-go?
4. **Connectivity:** Does the dashboard need to connect to live data sources?
5. **Data detail:** Will the dashboard offer an ability to drill down to see more context?
6. **Data density:** How information-rich will views of the data be?
7. **Interactivity:** Will the user benefit from interacting with the dashboard?
8. **Collaboration:** Is it important that your audience be able to easily share and collaborate on the dashboard?

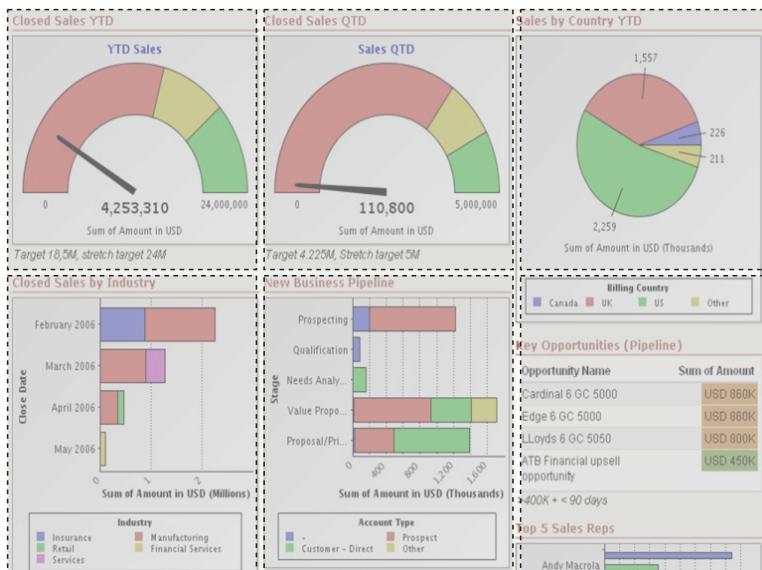
*The function of a dashboard is to communicate critical information to your audience in a way they can understand, delivered when and where they need the information.*

In the following table, we assess six forms of dashboards by their effectiveness in addressing the factors above (“+” means the form can work well for the specific factor; “-” means the form is not effective). Which forms perform well for the factors your audience cares about?

	Paper One-pager	Paper Presentation	Excel	Online app	E-mail / text message	Large screen
Timeliness	-	-	+	+	+	+
Aesthetic	+	+		+	-	+
Mobility	+				+	-
Connectivity	-	-		+	+	+
Data detail	-	+	+	+	-	
Data density	+	+			-	
Interactivity	-	-		+	-	-
Collaboration					+	-

## Structure

The standard practice for laying out a dashboard, unfortunately, has been to slot charts into a grid. Take this dashboard for example (with our grid overlay):



This rigid structure tells us nothing about how different charts relate to each other; offers no clue as to where to begin understanding the data; and nothing about what information is most important.

Creating a layout that helps frame the content of your dashboard may be the most under-valued area of dashboard design.

## Why structure matters?

Stephen Few, author of *Information Dashboard Design*, calls structure one of the greatest challenges of dashboard design:

*"Dashboard content must be organized in a way that reflects the nature of the information and that supports efficient and meaningful monitoring. Information cannot be placed just anywhere on the dashboard, nor can sections of the display be sized simply to fit the available space. Items that relate to one another should usually be positioned close to one another. Important items should often appear larger, thus more visually prominent, than less important items. Items that ought to be scanned in a particular order ought to be arranged in a manner that supports that sequence of visual attention." (Pervasive Hurdles to Effective Dashboard Design, Visual Business Intelligence Newsletter, January 2007)*

The structure of your dashboard is also an opportunity to define the “right” way to look at a problem or the business. How you choose to lay out the information shapes how your audience understands the big picture and how the smaller pieces fit together. At a more practical level, structure can serve as a navigational mechanism for the user. It shows where to start, and where to go next.

## Structure options

A good dashboard structure requires a deep understanding of how the system you are measuring works. There are many ways to break something down into manageable parts. For example, the performance of a (American) football game can be deconstructed in many ways: 1) by offense, defense, and special teams; 2) by down and distance; 3) by time period; 4) by drive; 5) by running vs. passing plays. A dashboard built around each of these organizing principles would tell a different story.

Choosing the right model is a dashboard-specific problem. In our experience, dashboards fall into three categories: flow, relationships, and grouping.

## Flow

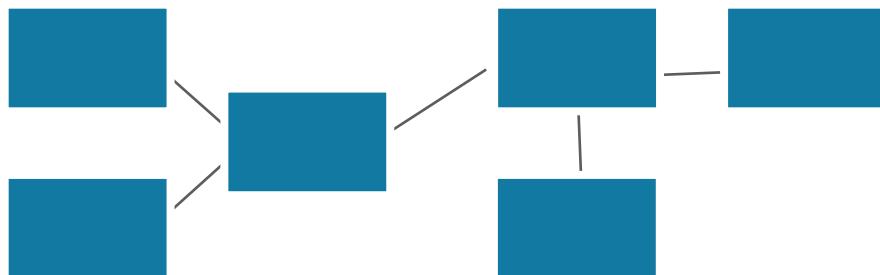


A flow-based structure emphasizes a sequence of events or actions across time. Systems that fit this model include leads moving through a sales pipeline, stages of customer support, and operational processes. Notice how the sales dashboard below is built around the flow of customers from leads through the pipeline, and ultimately to won or lost orders. The commitment to the vertical flow structure makes it clear to users how to think about the sales process.

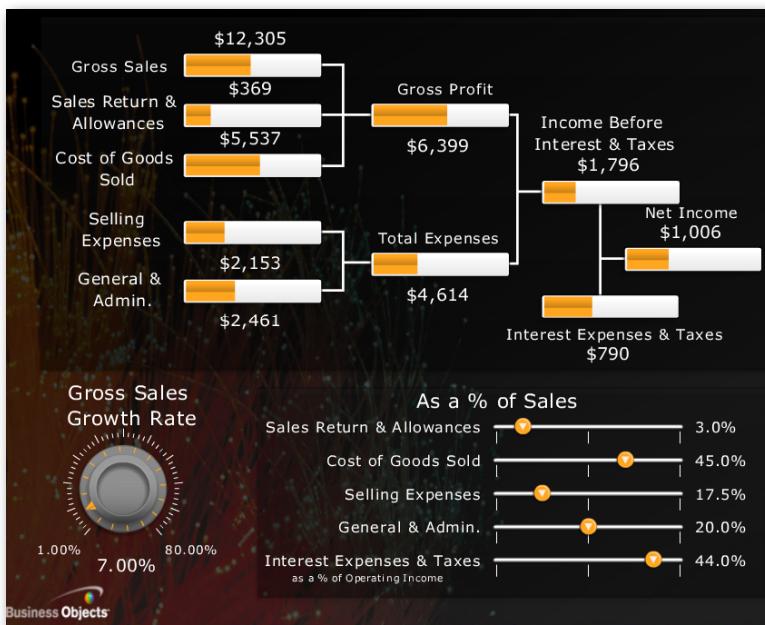


On2biz

## Relationships

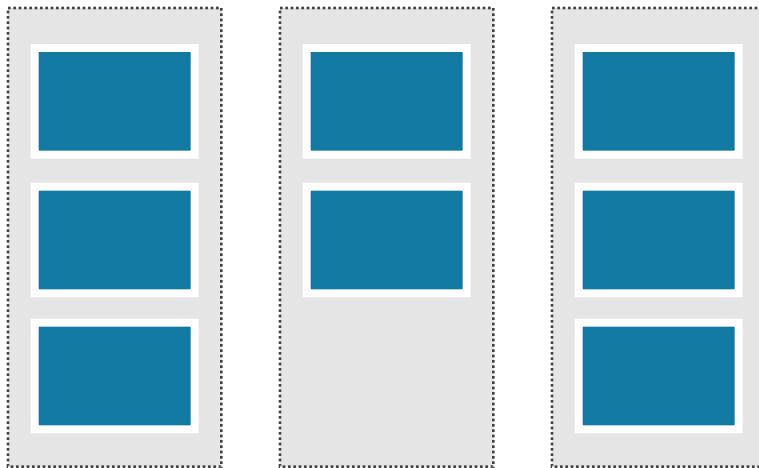


The structure of a dashboard can also emphasize the relationships between entities or measures. These relationships or connections may be mathematical, geographical, organizational, or functional. Below is a dashboard that explicitly shows the relationships between financial metrics to give users a model for understanding the factors driving net income.



*Business Objects*

## Grouping



The structure of last resort is to group related information into categories or a hierarchy. The simple act of putting similar things together can bring some logic and accessibility to an otherwise haphazard dashboard. The following dashboard from the New York Times financial section brings related metrics together into three categories. Based on their needs, different users will know where to start in reviewing the performance data.

HISTORICAL CHART		FINANCIALS TABLE				
<b>Google Inc.</b>		Change	Fundamentals   Income Statement   Cash Flow   Balance Sheet   SEC Filings			
<b>GOOG: Nasdaq</b>						
<b>Size</b>		<b>Per Share Data</b>		<b>Ratios</b>		
Market capitalization	146.0B	Earnings per share	\$14.41	Gross margin	61.51%	
Enterprise value	126.7B	Revenue per share	\$70.13	Return on equity	15.93%	
Revenues	22.3B	Cash flow per share	\$19.28	Price/Sales	6.6x	
Net income	4.6B	Dividends per share	\$0.00	Price/Earnings	32.0x	
No. of employees	19,786	Book value per share (MRQ)	\$99.85	Price/Book (MRQ)	4.6x	
All data trailing twelve months.		All data trailing twelve months except where noted.				All data trailing twelve months except where noted.
Enterprise value - Market cap plus debt, minority interest and preferred shares, minus cash and cash equivalents.		MRQ - Most recent quarter				MRQ - Most recent quarter

## Design principles

As you get closer to putting pencil on paper to design your dashboard, we'd like to lay out a few core design goals to use as reminders of what is important. We call these goals *design principles*. Below are a few key design principles that we use when we design

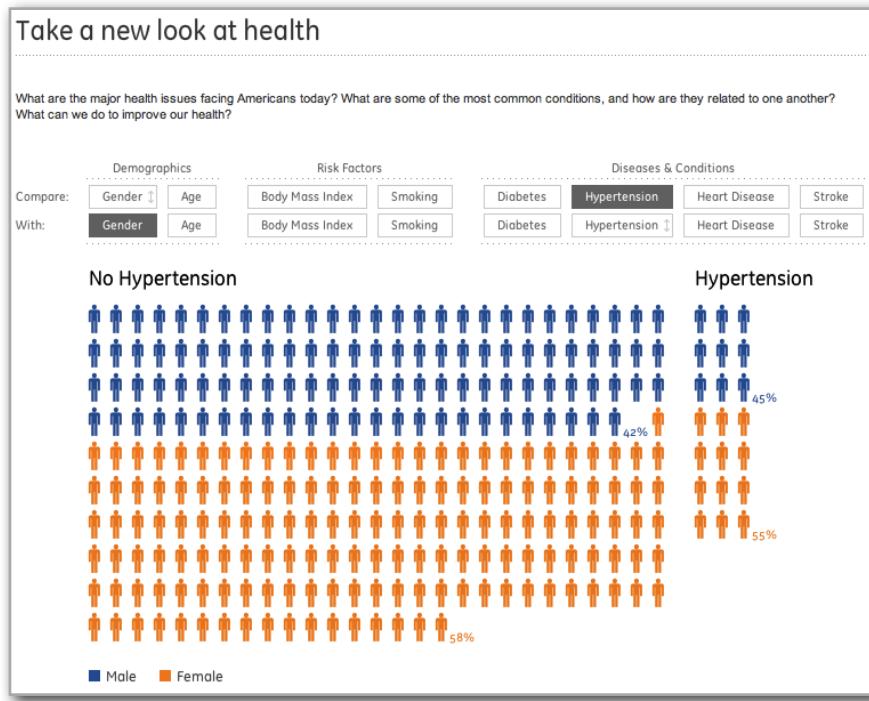
dashboards. By no means should you feel compelled to follow all of these principles; in fact, it is better to pick a one or two high priority principles to help stay focused.

## Compactness / Modularity

Some dashboards become large and unwieldy in an effort to create a single comprehensive view of an entire business or process. Eric Steven Raymond, writing about good software design (<http://catb.org/~esr/writings/taoup/html/ch04s02.html>), offers this guidance:

*"Compactness is the property that a design can fit inside a human being's head... Compact software tools have all the virtues of physical tools that fit well in the hand. They feel pleasant to use, they don't obtrude themselves between your mind and your work, they make you more productive."*

A dashboard can be broken into bite-sized pieces, each built around a key question. The GE Health Visualizer ([http://www.ge.com/visualization/health\\_visualizer/](http://www.ge.com/visualization/health_visualizer/)) by information visualization guru Ben Fry offers a great example of a compact design.



## Gradual reveal

Reveal information as the user expresses interest. In other words, don't bombard the user with all the information at once. We frequently use levels of increasing detail from (a) key metric to (b) context around the metric to (c) full breakout detail for the metric. Here's the interface of Datran Media's Aperture online advertising dashboard that shows this model:



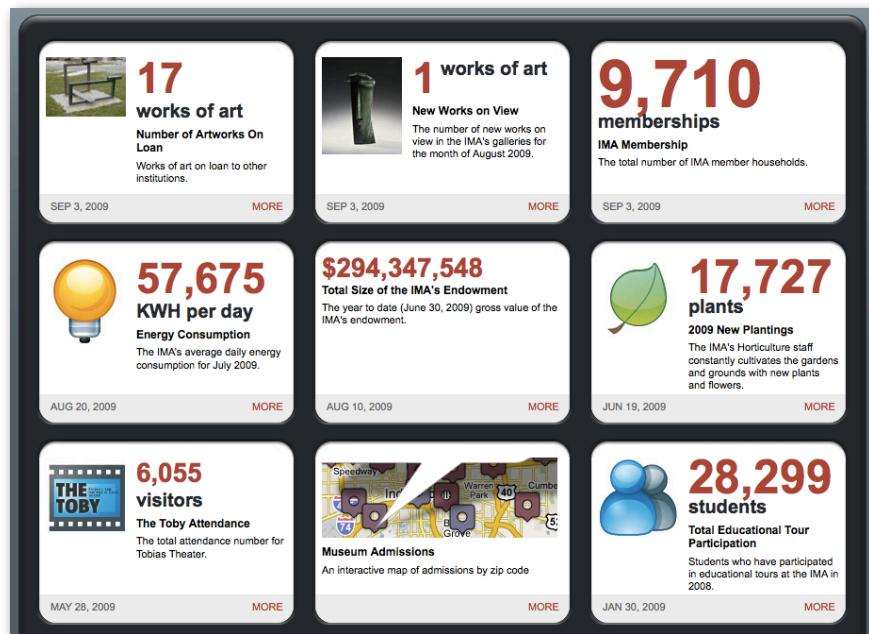
## Guide attention

It isn't good enough to make the information available; you need to use visual cues and functionality to draw the user to the things that matter most. A few mechanisms that can help are alerts, positioning on the page, and careful use of color and fonts. Trendly.com, a site that pulls information from Google Analytics, is specifically designed to highlight the most interesting changes in web analytics data.



## Support casual use

Minimize the barrier to entry for new users by avoiding feature overload, minimizing clicks for each task, and providing clear, concise descriptions of what things mean. The Indianapolis Museum of Art dashboard below has kept the interface simple, inviting and attractive for the visitors to their site who want to know what's going on. There is still plentiful detail behind each panel for people who want to know more.



## Lead to action

Empower the user to finish their task quickly and/or understand the action that should be taken based on the results. You can build in explicit guidance about what a change in a metric means, or who to contact to address an issue that is highlighted in the dashboard.

## Customizable

Build in flexibility to allow the dashboard to become relevant for different users. The most common way to allow users to customize the dashboard is by defining the scope of the data using filters. There is more that can be done: Does the dashboard let the user save a view of the data that they've configured? Does it offer easy ways to tag or highlight things that are important to them?

## Explanation before information

We need context and explanation to understand new and unfamiliar events. Providing data without this higher-level analysis is the difference between a chef presenting a fine dinner and fish monger throwing a fish at your head.

For many dashboards, there is time to interpret the results and provide a summary before presenting to your audience. Letting the data speak for itself can be a recipe for misinterpretation and confusion. The following quote about journalism offers broader perspective on how to present complex information:

*The most “basic” [journalistic] acts are reporting today’s news and providing current information, as with prices, weather reports and ball scores. We think of “analysis,” “interpretation,” and also “explanation” as higher order acts. They come after the news has been reported, building upon a base of factual information laid down by prior reports...*

*[However, there are some stories] **where until I grasp the whole, I am unable to make sense of any part.** Not only am I not a customer for news reports prior to that moment, but the very frequency of the updates alienates me from the providers of those updates because the news stream is adding daily to my feeling of being ill-informed, overwhelmed, out of the loop.*

- Jay Rosen, NYU Journalism Institute ([journalism.nyu.edu/pubzone/weblogs/pressthink/2008/08/13/national\\_explain.html](http://journalism.nyu.edu/pubzone/weblogs/pressthink/2008/08/13/national_explain.html))

## Functionality

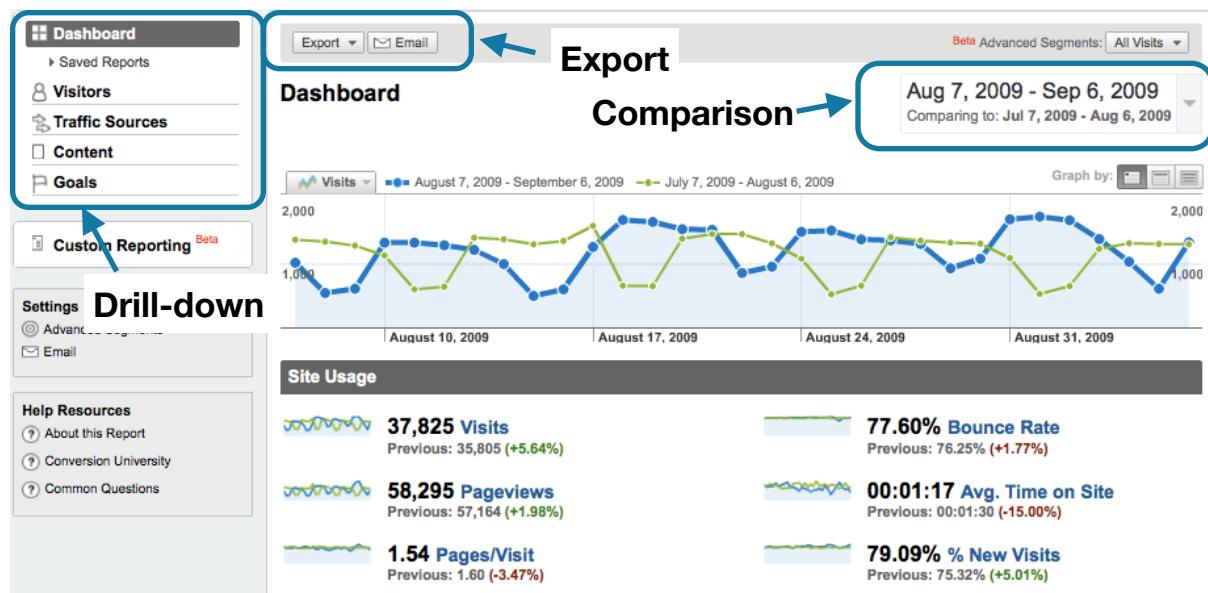
As we work our way from the big picture to the nuts and bolts of your dashboard design, we want to outline common features that can make your dashboard more useful (Part 3 will offer more detail on the best ways to implement some of these features). Depending on the form that you've chosen, the dashboard can be much more than simply charts on a page. Interactive elements highlight key information; user configuration let users customize their view of the data; advanced visualizations make complex data easy to understand and navigate.

The first group of features are the basics that should be considered for any dashboard. A second category of advanced features can differentiate your dashboard and provide exceptional user control and value.

### Basics

- **Drill down:** Ability to go from a summary metric or view to additional detail that provides more context and/or breakout of the information.
- **Filters:** Allow users to define the scope of the data in the dashboard to reflect their needs. Filters can either be global (refining scope for the entire dashboard) or local (refining scope for a specific chart or metric or view).
- **Comparison:** Ability to see two or more subsets of the data side-by-side. A line chart, for example, may let the user view two geographic regions as separate lines.
- **Alerts:** Highlight information based on pre-defined criteria. The alert may be activated when a metric goes outside of a particular threshold. For more detail on best practices in dashboard alerts, read this article [www.juiceanalytics.com/writing/dashboard-alerts-checklist/](http://www.juiceanalytics.com/writing/dashboard-alerts-checklist/)
- **Export / print:** Give users the ability to pull information out of a dashboard. Export to formats that let users do more with the data like Excel and CSV rather than PDF.

The Google Analytics dashboard offers elegant implementations of many of these features:



## Advanced

- **Text-based summary:** Automatically generated textual description of the key information in the dashboard. This can be as simple as a sentence that includes a couple important data points. A more sophisticated example is shown below in a web analytics solution by WebTrends:

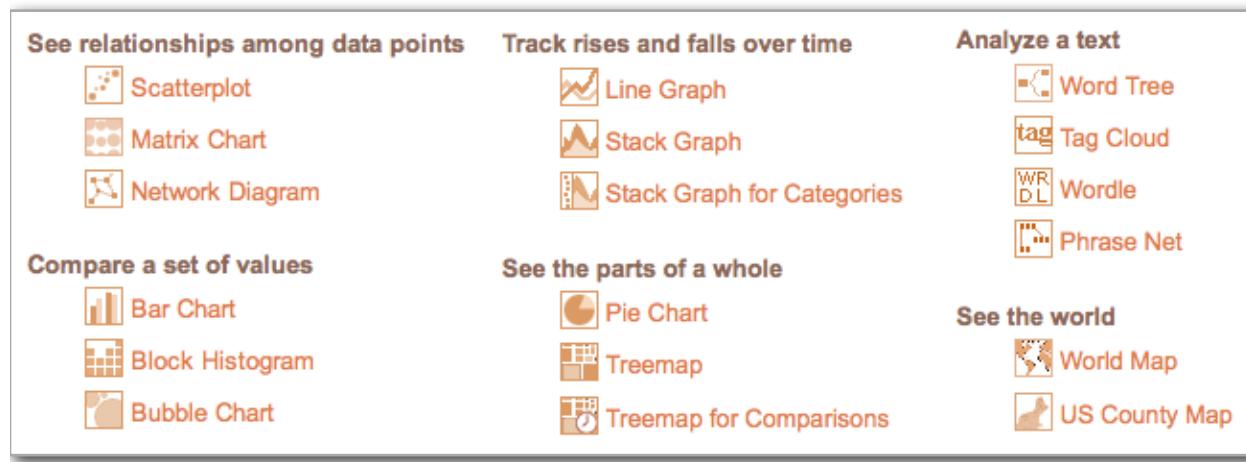
**1 - Homepage (Global) between Jun 16th - Jul 13th, 2009 (compared to May 19th - Jun 15th, 2009):**

Pages in this profile were visited **33.1 thousand** times (up **540%**). Each day, an average of **1.06 thousand** people visited pages in this profile (up **491%**), viewing pages **95.2 thousand** times over the selected period (up **1.31K%**). **20.7 thousand** visitors had never been to pages in this profile before (up **422%**). Visitors stayed on the site for approximately **6 minutes and 17 seconds** during each visit (up **76%**), viewing about **2.88** profile pages each in that time (up **121%**). **56.9 percent** of visitors (**down 31%**) left after viewing only the page through which they entered (this is the "bounce rate").

- **Starring/tagging:** Ability for users to identify things in the dashboard that are important to them. The virtual equivalent of circling a number with a red pen.
- **Annotation:** Allow users to add commentary to specific numbers or charts. The virtual equivalent of writing notes in the margin. WebTrends also offers an annotation feature:



- **Save / track changes:** The more a user configures a dashboard to their unique needs, the more important it becomes to allow them to save what they have created. For an exquisite example of saving changes as you go along, see the tee-shirt customization site Click Shirt (<http://www.click-shirt.com/>).
- **Advanced visualizations:** If it is useful to show more complex data in the dashboard, a variety of advanced visualizations can help make it digestible. A few visualization types to consider include geographic map, treemap, network diagram, tag cloud, scatterplots and bubble charts. But be careful, using complex visualizations incorrectly can leave your audience feeling lost and confused. A good place to explore some of these more innovative visualizations is IBM's Many Eyes site (<http://maneyes.alphaworks.ibm.com/maneyes/>):



## Building Blocks

Part 2 of our guide gives you the building blocks for constructing your dashboard. Like constructing a house, we wanted to focus on framing the structure before worrying about painting the walls and installing the kitchen appliances. In this paper we've addressed these topics:

1. **Form:** In what format is the dashboard delivered?
2. **Structure:** How is the dashboard laid out to help users understand the big picture?
3. **Design principles:** What are the fundamental objectives that will guide your design decisions?
4. **Functionality:** What capabilities will the dashboard include to help users understand and interact with the information?

In Part 3, we will focus on information design -- presenting information in clear and concise ways. In addition, we will offer our perspective on designing an interface that is user-friendly and attractive.

# Part 3: Information Design

## Clear presentation of information

The third part of our dashboard design guide provides practical tips for putting information on the page in a way that communicates effectively to your audience.

We stand on the shoulders of giants in the area of information design, including visualization guru Edward Tufte, visual business intelligence critic and teacher Stephen Few, and numerous leaders in the field of web design. This paper is our attempt to synthesize some of the most important best practices while adding a few extra wrinkles.

Information presentation is a balancing act—How do you convey a lot of information without making it feel overwhelming? How do you capture attention without distracting your audience? How do you make information feel simple yet profound?

As we've done throughout this series, we will tackle the problem from the outside in. First we share best practices for designing a clear, aesthetically-pleasing page. Next we concentrate on the charts, table and visualizations that communicate the information. Here's what you can look forward to:

### Section 1: Interface design

1. Organize the dashboard page like a web design expert
2. Choose the appropriate use of color to enhance your dashboard
3. Make the right typography decisions to ensure attractive, readable text

### Section 2: Information display

1. Pick the chart type that best fits your data
2. Style charts to be attractive and effective
3. Learn about advanced visualization and features for your dashboard

## Section 1: Interface design

Simplicity is a primary goal of many well-designed websites—limiting visual clutter to help users easily navigate and understand the content. Dashboards share the same goal. It is no surprise then that we can learn a lot from the rules and tools of web design to help guide our thinking on creating dashboard interfaces. We can learn about:

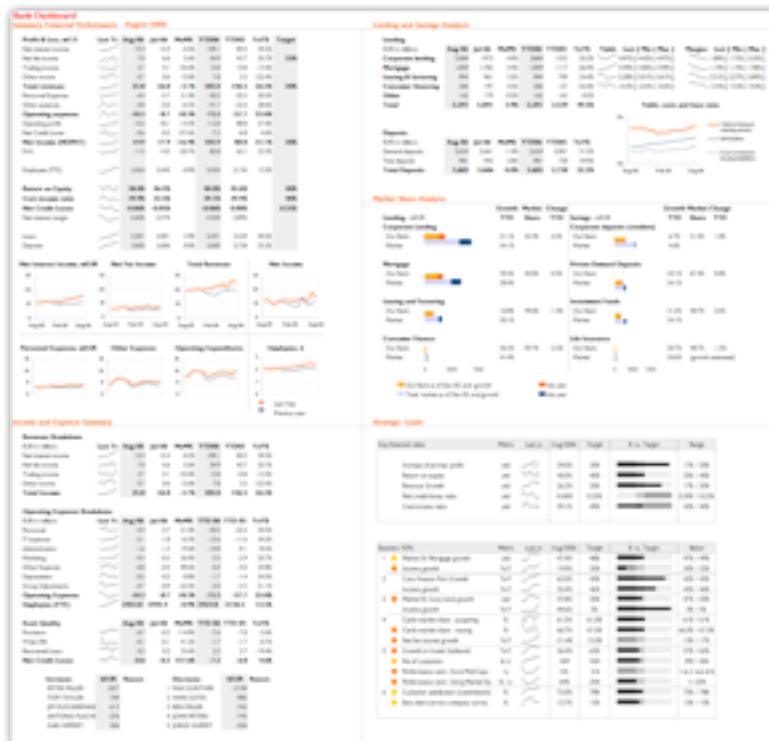
**Organizing the page.** Where should you place the most important content? How do you lay out charts and text to enable visual rhythm? How can white space help your audience absorb information?

**Color.** What meaning does color bring to the dashboard? How do you pick the appropriate color palette and scheme for your situation?

**Typography.** Why does it matter what fonts are used? How do you consistently use fonts to enhance the interface?

### Organizing the page

The little things in a dashboard can make a big difference—like where you place the key metrics, where you place charts, and how much information you try to fit into a page. Dashboards like the award-winning International Bank Dashboard (below) succeed at information design. However, its page layout leaves something to be desired. The data is compressed to fit the page and readers can't easily determine what is the most critical information.

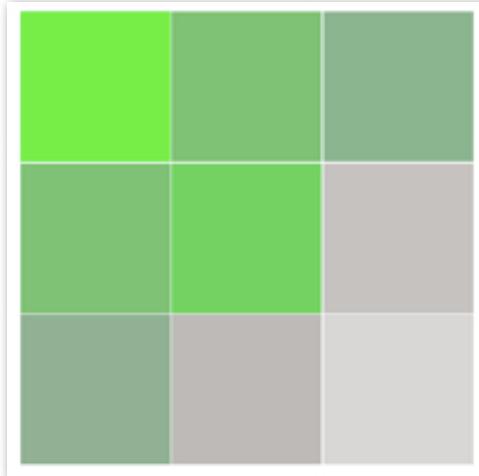


[www.bonavistasystems.com/MicroChartsCompetitionDashboards01.html](http://www.bonavistasystems.com/MicroChartsCompetitionDashboards01.html)

A few things to keep in mind when laying out your dashboard:

## Pay attention to attention

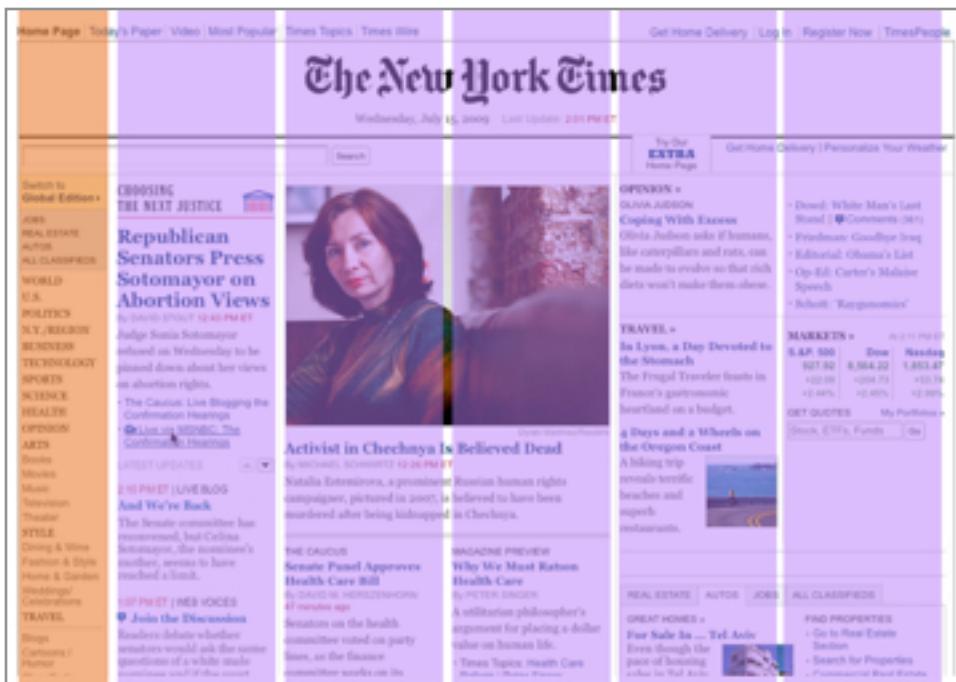
You'll want to position the most important information where people look first. But how to know where someone will look on the page? Fortunately, studies show that people tend to scan a page in a similar manner. Imagine the image to the right is overlaid on your dashboard page. The research indicates that users look first for information on the top and left. Users also focus their attention down the left side. The center gets a fair bit of attention as well. But the bottom and right may not be noticed by your user at all.



## Grids

Many web designers use something called a grid system—a series of columns and “gutters” of certain widths—to ensure that key lines in their designs align. This approach brings a coherence and order to the page that puts users at ease.

We can overlay a grid on a well-designed site like the New York Times to see how this system gets applied in practice.

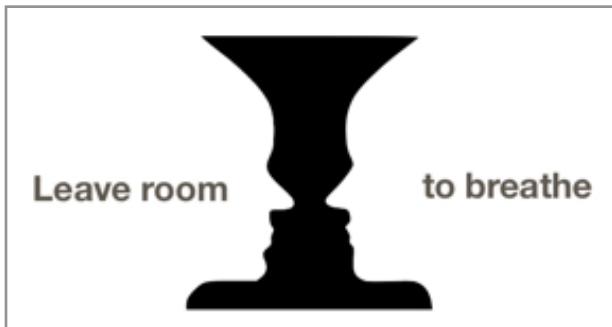


Not everything fits into one column, but it is obvious that this site has a pre-defined grid and sticks faithfully to it. The result is a clean, effective page layout. Here are two reference articles to learn more about grid layouts:

- [www.subtraction.com/pics/0703/grids\\_are\\_good.pdf](http://www.subtraction.com/pics/0703/grids_are_good.pdf)
- [www.smashingmagazine.com/2007/04/14/designing-with-grid-based-approach/](http://www.smashingmagazine.com/2007/04/14/designing-with-grid-based-approach/)

## White space

We don't just see objects themselves; we also see the space that is not there. White space in interface design is very important and too often overlooked. Maximizing dashboard real estate must also mean creating places for the eye to "rest" so that the non-white space has more impact. When we don't have sufficient spacing, everything runs together and we can't see what is most important.



White space can be used to delineate sections or help users see groupings of content in a dashboard. Using white space may mean sacrificing one extra chart or metric, but it can make a huge difference in user comprehension.

## Color

More often than not, dashboards get lit up with color like an over-dressed Christmas tree. The color is applied indiscriminately and adds little to the meaning of the dashboard. Appropriate use of color requires restraint. In our dashboard designs, we typically start by using only grey, then we gradually add color where it conveys useful information.

### Color brings meaning

Color can draw your eye to what is important and tie together similar things. For example, if we increase color brightness, it will attract attention and make a point seem more important. Similarly, use of the same color hue can be used to connect things that are related.

At a more subtle level, the color scheme we choose can evoke an emotion or feeling about the dashboard. Colors can be broken into high-level dichotomies such as "earhttones" versus "unnatural" colors. We perceive earhttones as calming (Edward Tufte

has said that these are the kinds of colors you want to use if you just want to use color very gently on your page). In contrast, unnatural colors jump out at your audience, making them ideal for showing an alert.

## Meaning in color

<b>Earhtones</b> Gentle browns, blues. Calming, sinks into the page 	<b>Unnatural colors</b> Alarming, unnerving, draws attention. 
<b>Cool</b> Soothing, restful, calm 	<b>Warm</b> Optimistic, active, vivid 
<b>Increasing color intensity</b> Increasing saturation and brightness draws the eye and means the point is more important 	

## Color to display data

When you are using color in your graphs to represent data, there are three types of color schemes to consider:

- **Sequential** when you are ordering values from low to high.
- **Divergent** when the values are ordered and there is a critical mid-point (e.g. an average or zero).
- **Categorical** when data falls into distinct groups (e.g. countries) and therefore requires contrast between adjacent colors.

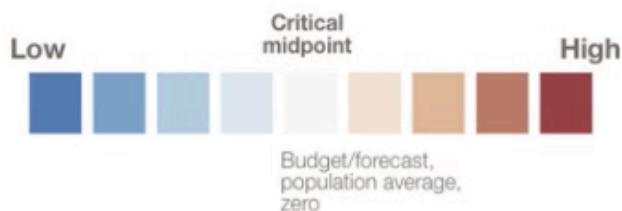
## Sequential

Colors can be ordered from low to high



## Diverging

## Two sequential schemes extending out from a critical midpoint value



## Categorical

Lots of contrast between each adjacent color



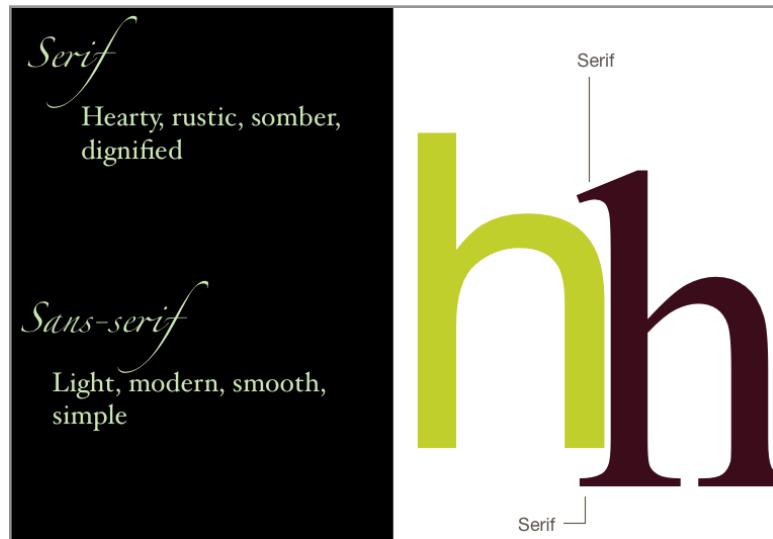
# Typography

Typography is an obsession for some; it can include everything from choosing a typeface (i.e. font) to picking the right point size, kerning, tracking, and leading. In the meantime, you've got a dashboard to make. We conclude this section with a unique framework for making decisions that ensure quality typography in your dashboard.

## Fonts are like wine

In the world of wine, we have reds and whites. The world of fonts is similarly bisected into serif and sans-serif fonts. Serif is the name for the little decorative feet that come off the end of serif letters. Sans is french for “without” so sans-serif fonts don’t have the feet. Serif fonts are like red wines. Sans-serifs are like whites.

Among serif fonts, Georgia, Times New Roman, and Palatino are generally available. Think of these as the Merlot, Cabernet Sauvignon and Pinot Noir of fonts. Georgia is a lovely font that works well on the screen, at different sizes and in bold and italics. It's our editor's choice. Palatino can be quite elegant, while Times New Roman is workmanlike.



On the sans-serif side, some common fonts are Arial, Helvetica, Trebuchet, Verdana, and Tahoma. Trebuchet is a sassy font. Verdana and Tahoma are cousins; Tahoma is just a horizontally compressed Verdana. Helvetica had a movie made about it, so that gives you an indication its popularity.

## How we read

According to research at Cambridge University...well, you can read the details below:

Aoccdrnig to rscheearch at Cmabrigde uinervtisy, it deosn't mttaer waht oredr the ltteers in a wrod are, the olny iprmoetnt tihng is taht the frist and lsat ltters are at the rghit pclae. The rset can be a tatol mses and you can sitll raed it wouthit a porbelm. Tihs is bcuseae we do not raed ervey lteter by it slef but the wrod as a whole.

<http://blogs.msdn.com/fontblog/default.aspx?p=2>

It's amazing how quickly we can read this paragraph, given that very few letters are in the right shape. We recognize words through a combination of letter recognition and word shape recognition. The words in this paragraph all have the right starting and ending letters and they have approximately the correct word shape. This leads to an interesting conclusion: with capital letters, we do not have a distinctive word shape. All caps is less legible than regular text and generally should be avoided.

Fortunately there are lots of other ways to emphasize text. Look at the following text treatment:

"If we don't get out of the woods soon, we'll be *eaten by a bear*," whispered Timmy.

"If we don't get out of the woods soon, we'll be **eaten by a bear**," whispered Timmy.

What is the effect when you bold or italicize text? Italics add a sense of emphasis and urgency. Italics can also look classy. Bold text, in contrast, is urgent and loud. When bold text is part of a sentence, you'll tend to look at it first. Here are your options for text emphasis:

You can add *italic* letters.

You can **bold** your important point.

You can **darken** your important text.

You can **use color** to emphasize text.

You can **combine** effects.

**Less effective**

You can UPPERCASE your important text.

You can **bold-italics** your important text.

You can **use color** to emphasize text.

## A simple font framework

With that background, we'd like to offer a simple framework for effective use of fonts in your dashboard. With just few simple decisions, you can ensure that the text on the dashboard will both look good and communicate effectively. The majority of text on the page falls into four categories:

- **Body** text is clean, readable content
- **Headers** separate and name major sections of your work
- **Notes** describe additional things the reader should be aware of. These should fade into the background unless we call attention to them.
- **Emphasis** text is what we want our reader to pay particular attention to.

The following table describes an approach for deciding how to display each of these text types. The yellow highlights indicate where you need to make decisions.

	<b>Purpose</b>	<b>Size</b>	<b>Font</b>	<b>Color</b>	<b>Style</b>
<b>Body</b>	Clean readable text, 50-80% of your text will look like this.	10-16pts	sans-serif: Arial, Tahoma, Verdana serif: Georgia, Times	Neutral	Normal No bold, no italic 1.2 line spacing
<b>Header</b>	Separate and name major sections of your writing.	150-200% of <b>body</b>	Same as <b>body</b> or flip serif/sans-serif	Neutral	Normal, bold, or italic Whitespace above
<b>Notes</b>	Additional things a user should be aware of, data sources, metric calculations. "Fade into the background"	85% of <b>body</b>	Same as <b>body</b>	De-emphasized, lower contrast	Normal No bold, no italic
<b>Emphasis</b>	Draw the eye to key points you need to make.	Same as <b>body</b>	Same as <b>body</b>	High impact color	<b>Choose one or both</b> Bold or italic

### Juice's Simple Font Framework

You need to make three basic decisions:

1. Choose size and font of the body text
2. Decide if the header is going to flip to serif or sans-serif—and whether it is going to have any style
3. Decide what to do about emphasis—color or (bold or italic)

A few things don't fit neatly into one of the four text categories listed above, such as table headers and graph titles. We tend to use a combination of styles to handle these exceptions. Stick to this framework and we guarantee your dashboard will look better.

## Section 2: Information display

Your dashboard needs to tell a story with data. To do so, you'll need to create charts and tables that highlight the right information and are easy to read. Your audience is probably distracted and doesn't love looking at data (as much as you do), but with the right choices about information display you can still reach them.

This section starts by addressing the age-old question: What is the right chart to show my data? Next we provide tips and tricks for better chart and table design. Finally, we have compiled a set of best-in-class resources and hints for advanced data visualization techniques.

## Choosing the right chart

We are often asked “what is the right chart for my data?” Unfortunately there is no secret decoder ring to point at data and see what kind of chart would work best. While we wait on that invention, let’s use an understanding of data types and chart types to uncover some of the mystery.

### Types of data

There are two major types of data: categorical (i.e. dimensions) and quantitative (i.e. measures or metrics). If you were analyzing a zoo, categorical data would be the different species, gender, and grouping by furry, feathery, or scaly. Quantitative data would include the number of animals, animal weight, number of teeth, etc. The following table describes the different data types:

	Meaning what?	Examples
<b>Categorical</b> (dimensions)		
- Nominal	The ordering of the values has no intrinsic meaning	Department (HR, Sales, Operations, ...), US States
- Ordinal	Ordered, "Every value has a place"	Months of the year, grades in school, tenure with employer
- Time Series	Dates and times	2009Q1, 2009Q2, ..., June 9, 2009, June 10, 2009, ...
<b>Quantitative</b> (measures)		
- Additive	Adding values makes sense, zero is meaningful	Total employees, market share
- Non-additive	Only differences in values makes sense	Blood pressure, temperature

Data types gives us the first piece of the puzzle for choosing the right chart. Let's add a couple additional pieces:

- **Use charts that maximize user comprehension.** There are things that people can judge very accurately—the length of a line and position in 2D space. Then there are things that people can judge only semi-accurately—width, area, color intensity, radial distance. You want to use charts that support quick comprehension of values (e.g. line, bar) and avoid charts that are hard to interpret (i.e. pie, 3D scatterplots).
- **Don't lie with data.** A couple simple rules for accurate representation of data: 1) lines connect things that are related; 2) the length of bars is directly proportional to the values behind graphed (if a number is 2x bigger, the bar should be 2x bigger). The same goes for the proportionality of areas.

## Choosing the right chart type

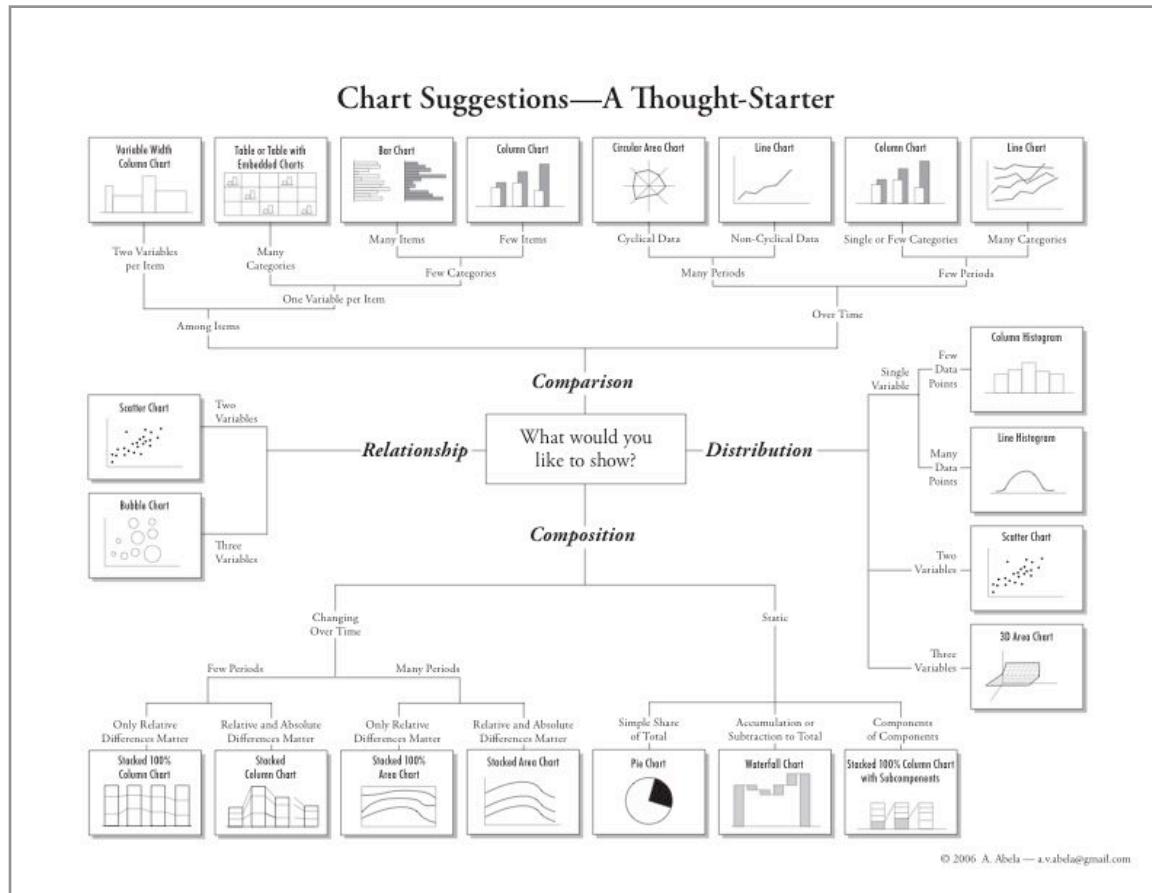
Now we can combine these rules and our understanding of data types to show how to choose the right chart for your data. In the following table, the rows are your quantitative data type and the columns are your categorical (or quantitative) data type.

	Nominal (Business unit)	Ordinal (Tenure, Grade, Age)	Time Series	Quantitative additive (Income, market share, costs)	Quantitative non-additive (temp.)
Quantitative Additive	<b>Bars</b> Must start from zero Sort in descending order	<b>Bars or Lines</b> Must start from zero Must maintain order	<b>Points or lines</b>	<b>Points</b>	<b>Points</b>
Quantitative Non-additive	<b>Bars or points</b> Sort in descending order	<b>Points or lines</b> Must maintain order	<b>Points or lines</b>	<b>Points</b>	<b>Points</b>

The table displays five examples of charts for each category:

- Quantitative Additive / Nominal:** Bar chart showing Regional % of Total Expenses by Region (West, East, North, South).
- Quantitative Additive / Ordinal:** Bar chart showing Q1 2000 Calls by Region (North, East, South, West).
- Quantitative Additive / Time Series:** Line chart showing 2000 Sales over time (Jan to Dec).
- Quantitative Additive / Quantitative additive:** Scatter plot showing Correlation of Employee Heights and Salaries.
- Quantitative Additive / Quantitative non-additive:** Scatter plot showing Correlation of Employee Heights and Salaries.
- Quantitative Non-additive / Nominal:** Bar chart showing Regional % of Total Expenses by Region (West, East, North, South).
- Quantitative Non-additive / Ordinal:** Bar chart showing Q1 2000 Calls by Region (North, East, South, West).
- Quantitative Non-additive / Time Series:** Line chart showing 2000 Sales over time (Jan to Dec).
- Quantitative Non-additive / Quantitative additive:** Scatter plot showing Correlation of Employee Heights and Salaries.
- Quantitative Non-additive / Quantitative non-additive:** Scatter plot showing Correlation of Employee Heights and Salaries.

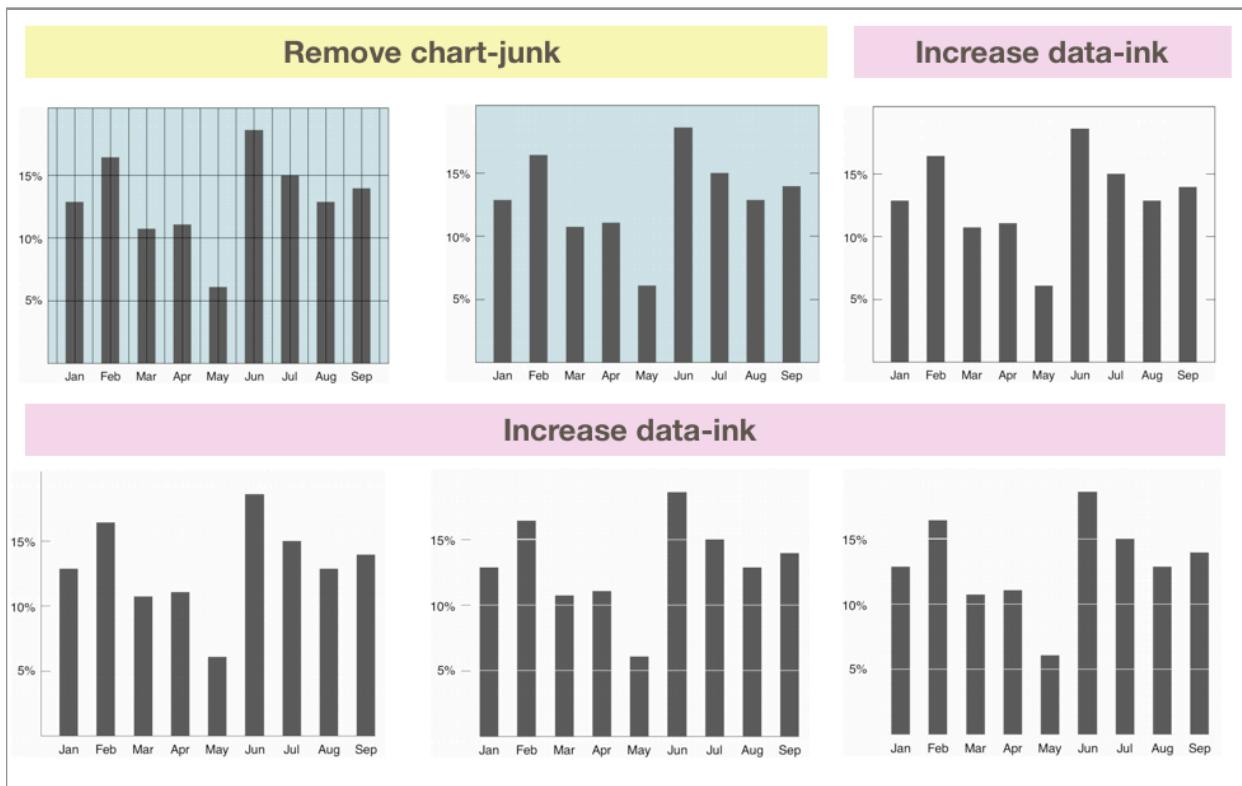
For another perspective on this problem, see Andrew Abela's "Chart Suggestions" diagram ([extremepresentation.typepad.com/blog/2006/09/choosing\\_a\\_good.html](http://extremepresentation.typepad.com/blog/2006/09/choosing_a_good.html)).



## Fundamentals of chart and table design

Out of the box, most charting programs break the rules for good chart design. We've used examples from one of the chief offenders, Microsoft Excel, to show how you can get to clean, readable charts.

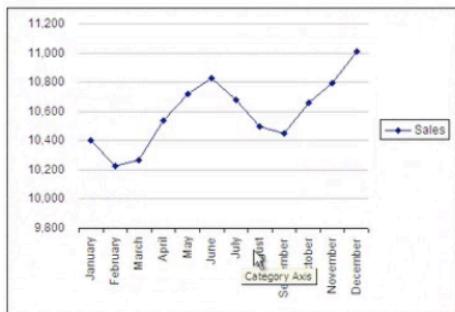
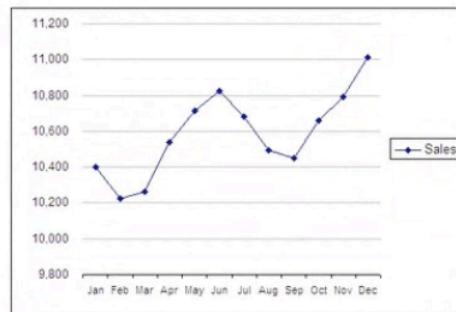
**1. Reduce chart-junk and increase data-to-ink ratio.** These are the first two commandments of Edward Tufte. Reduce chart junk by removing elements that are decorative or ornamental. Three dimensional chart effects, for example, add nothing of value to your chart. Increase data-to-ink ratio by making every pixel tell a story about your data.



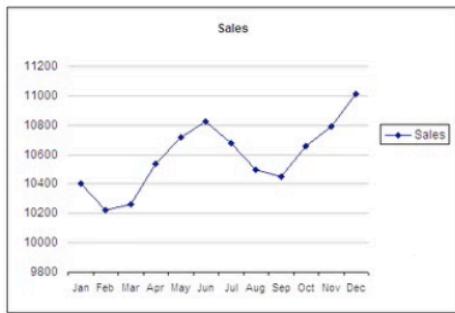
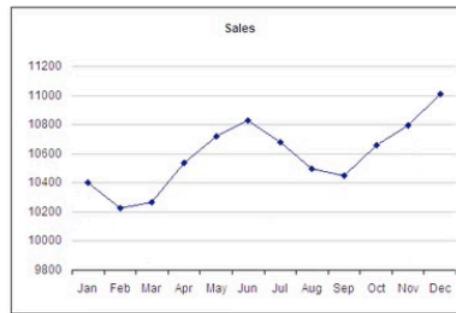
**2. Maximize contrast.** Maximize the contrast between your data and the background. The standard Excel default chart, for example, makes it more difficult than necessary to distinguish the line from the background. A white background and de-emphasized gridlines can help.



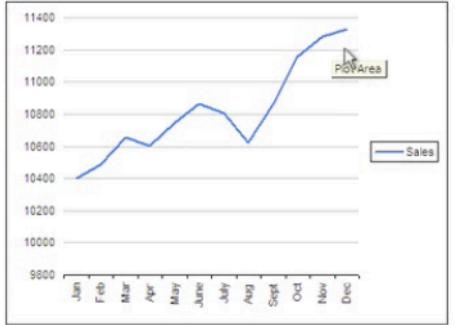
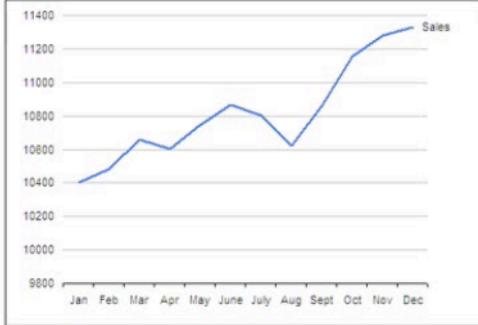
**3. Readable labels.** Whenever possible, avoid rotated labels; they are hard for people to read and distract from focusing on the numbers.

**Bad****Good**

**4. Don't repeat yourself; repetition is bad.** It's not necessary to have both a legend and a title for single series graphs. Likewise, the title of a chart may suffice to explain what the reader is looking at.

**Bad****Good**

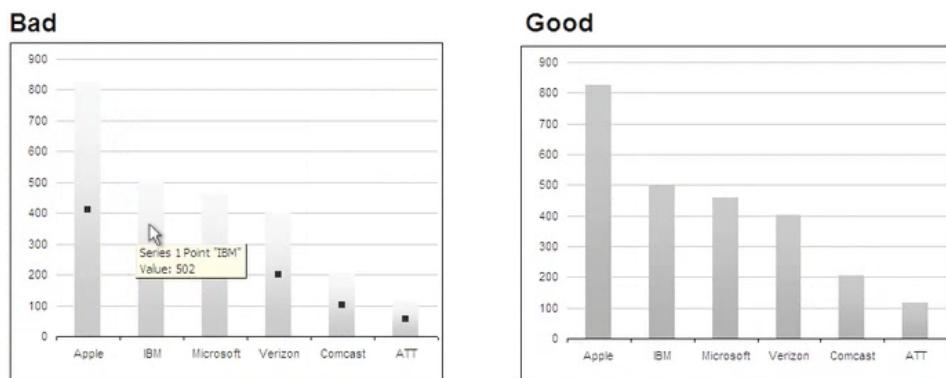
A useful alternative to a legend is to label the individual data series directly.

**Worse****Better**

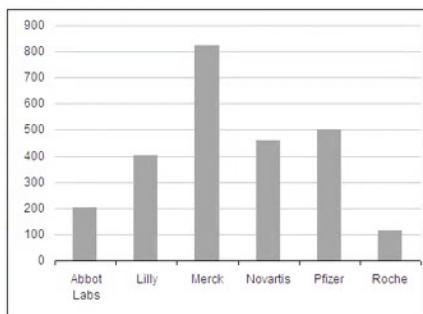
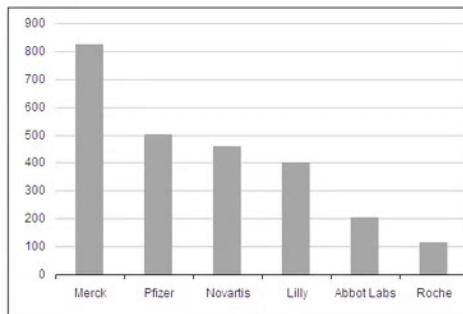
**5. Avoid smoothing and 3D.** Avoid adding a smoothing feature to your line; it gives the impression of data points that are not there. Similarly, glossy 3D effects are a visual that was impressive in 1999 but contributes no value to your chart.



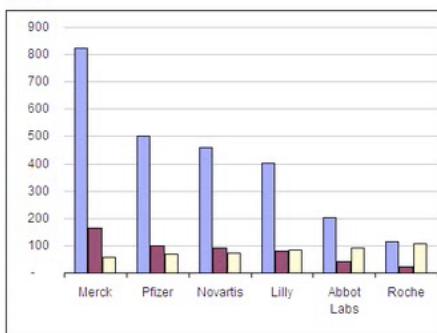
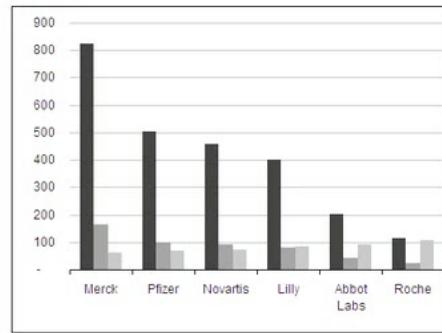
**6. Careful use of gradients.** Use flat colors or a bare minimum gradient. Ensure that the bar endpoint is visible. When the gradient fades toward the endpoint, it reduces the ability to clearly see the length of the bar.



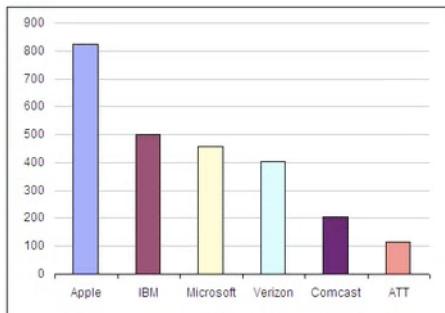
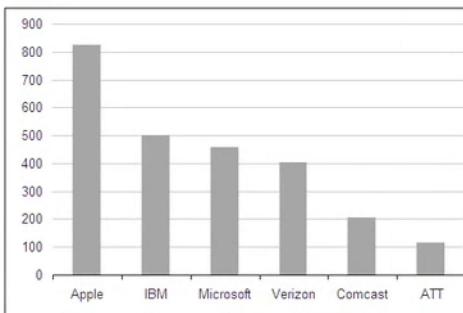
**7. Sort for comprehension.** Add structure and clarity to the chart by sorting by a metric of interest.

**Bad****Good**

**8. Use color variants.** If you are displaying multicolumn or stacked charts, use variants on a hue or grey to show different data series.

**Bad****Good**

Also, don't vary the colors by point. This creates a lot of unnecessary visual noise and makes similar colors seem related. In addition, bright colors get more perceived emphasis.

**Bad****Good**

## Tables

While graphs allow us to see the shape of data, tables allow us to perform precise lookups and comparison between small numbers of values. Here are a few addition design tips to consider when creating tables:

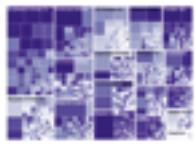
- Remove gridlines
- Use lines or whitespace to separate areas that are conceptually different
- Display the smallest amount of numbers that you can to support the needs of the table
- Use consistent column and row spacing to create horizontal and vertical rhythm

Team	1999	2000	2001	2002	Average Salary (\$ millions)			
					1999	2000	2001	2002
Arizona Diamondbacks	\$61,184,250	\$72,346,275	\$72,505,825	\$77,893,950	61.2	72.3	72.5	77.9
Atlanta Braves	\$58,134,250	\$70,448,200	\$74,073,950	\$75,379,325	68.1	70.4	74.1	75.4
Baltimore Orioles	\$73,057,675	\$70,213,300	\$62,436,500	\$47,260,525	73.1	70.2	62.4	47.3
Boston Red Sox	\$55,142,125	\$64,950,275	\$85,592,900	\$90,305,050	55.1	65.0	85.6	90.3
Chicago White Sox	\$22,740,725	\$26,839,225	\$57,743,525	\$52,826,700	22.7	26.8	57.7	52.8
Chicago Cubs	\$51,889,225	\$50,449,450	\$61,553,675	\$67,581,100	51.9	50.4	61.6	67.6
Cincinnati Reds	\$52,588,575	\$43,395,550	\$43,488,350	\$37,542,000	28.6	43.4	43.5	37.5
Cleveland Indians	\$60,769,300	\$72,962,375	\$76,645,825	\$65,757,875	60.8	73.0	76.6	65.8
Colorado Rockies	\$53,716,200	\$54,563,575	\$65,803,700	\$52,639,850	53.7	54.6	65.8	52.6
Detroit Tigers	\$30,450,600	\$53,949,225	\$44,492,125	\$49,150,000	30.5	53.9	44.5	49.2
Florida Marlins	\$17,477,775	\$17,303,450	\$29,586,800	\$37,482,075	17.5	17.3	29.6	37.5
Houston Astros	\$49,643,275	\$47,469,925	\$55,909,875	\$58,748,525	49.6	47.5	55.9	58.7
Kansas City Royals	\$22,794,225	\$20,922,325	\$30,726,725	\$40,738,800	22.8	20.9	30.7	40.7
Los Angeles Dodgers	\$70,773,175	\$81,596,550	\$93,949,100	\$91,202,850	70.8	81.6	93.9	91.2
Anaheim/Los Angeles Angels	\$39,265,275	\$42,886,800	\$37,554,975	\$55,108,825	39.3	42.9	37.6	55.1
Milwaukee Brewers	\$38,329,400	\$28,519,800	\$39,897,525	\$43,351,175	38.3	28.5	39.9	43.4
Minnesota Twins	\$18,502,400	\$15,884,125	\$22,548,800	\$38,677,875	18.5	15.9	22.5	38.7
Montreal/Washington Nationals	\$14,977,325	\$30,006,750	\$28,978,750	\$34,527,225	15.0	30.0	29.0	34.5
New York Mets	\$57,824,475	\$79,509,775	\$83,191,450	\$90,993,850	57.8	79.5	83.2	91.0
New York Yankees	\$75,923,825	\$79,774,350	\$88,541,850	\$108,559,125	75.9	79.8	88.5	108.6
Oakland Athletics	\$22,340,700	\$29,603,075	\$31,306,250	\$36,740,500	22.3	29.6	31.3	36.7
Philadelphia Phillies	\$26,118,525	\$40,782,750	\$40,061,700	\$51,745,525	26.1	40.8	40.1	51.7
Pittsburgh Pirates	\$18,498,050	\$27,815,700	\$42,498,850	\$38,485,850	18.5	27.8	42.5	36.5
San Diego Padres	\$42,703,875	\$45,684,175	\$35,493,825	\$35,711,200	42.7	45.7	35.6	35.7
Seattle Mariners	\$48,041,825	\$56,649,050	\$67,546,875	\$80,282,675	48.0	56.6	67.5	80.3
San Francisco Giants	\$44,943,550	\$51,670,975	\$58,641,350	\$72,499,850	44.9	51.7	58.6	72.5
St. Louis Cardinals	\$42,313,275	\$56,901,725	\$66,612,800	\$71,248,325	42.3	56.9	66.6	71.2
Tampa Bay Rays	\$29,269,400	\$50,617,050	\$50,881,125	\$30,696,425	29.3	50.6	50.9	30.7
Texas Rangers	\$71,956,675	\$68,073,000	\$71,374,525	\$90,777,700	72.0	68.1	71.4	90.8
Toronto Blue Jays	\$42,797,425	\$44,459,925	\$67,677,225	\$66,262,350	42.8	44.5	67.7	66.3
Average	\$43,338,913	\$49,875,624	\$56,243,876	\$59,605,910	43.3	49.9	56.2	59.6

Table design: before and after

## Resources for advanced dashboard features

There is so much more we could cover in the area of information visualization, but your printer is short on paper. With the remaining page, we have compiled some of the best resources and best practices for more advanced visualizations and dashboard features.

Type	What is it?	Two tips	Where to find out more
Sparklines	Small word-sized graphics 	Sparklines can be embedded in tables to help spot trends and values in the data  Avoid trying to display too much information in each tiny graphic	Sparklines: Theory and Practice from Edward Tufte's discussion boards  <a href="http://www.edwardtufte.com/bboard/q-and-a-fetch-msg?msg_id=0001OR">www.edwardtufte.com/bboard/q-and-a-fetch-msg?msg_id=0001OR</a>
Treemaps	Visualization of hierarchical data 	Use measures that add-up for box size (e.g. sales); use rates or percentages for box color (e.g. change in sales)  The data layers need to have a hierarchical structure (e.g. continents->countries->cities)	10 Lessons in Treemap Design <a href="http://www.juiceanalytics.com/writing/10-lessons-treemap-design/">www.juiceanalytics.com/writing/10-lessons-treemap-design/</a>  Treemaps for space-constrained visualization of hierarchies by Ben Shneiderman  <a href="http://www.cs.umd.edu/hcil/treemap-history/">www.cs.umd.edu/hcil/treemap-history/</a>
Geographic maps	Heatmaps or point/bubble overlay on a map 	Include only as much detail in the map itself as is useful for the audience (e.g. road-level detail may be distracting)  Before using a map, make sure location is critical to the users understanding; sometimes a simple chart or table can be just as effective	Introduction to Geographic Data Visualization  <a href="http://www.perceptualedge.com/articles/visual_business_intelligence/geographical_data_visualization.pdf">www.perceptualedge.com/articles/visual_business_intelligence/geographical_data_visualization.pdf</a>
Alerts	Dashboard indicators displayed when a measure exceeds a threshold 	Avoid “over alerting”—too many flashing lights will quickly numb the users  Create actionable alerts where there is a clear next step	A Dashboard Alerts Checklist  <a href="http://www.juiceanalytics.com/writing/dashboard-alerts-checklist/">www.juiceanalytics.com/writing/dashboard-alerts-checklist/</a>

Type	What is it?	Two tips	Where to find out more
Filters	<p>User configuration to set the scope of the values in the dashboard</p> 	<p>Use small visualizations in filters to show the size or frequency of the selectable dimension</p> <p>Display the filter selections in the title of the dashboard so a printed copy accurately describes the data</p>	<p>Scented Widgets: Improving Navigation Cues with Embedded Visualizations (Univ. of CA, Berkeley)</p> <p><a href="http://vis.berkeley.edu/papers/scented_widgets/">vis.berkeley.edu/papers/scented_widgets/</a></p> <p>5 Features of Effective Filters</p> <p><a href="http://www.juiceanalytics.com/writing/five-features-effective-filters/">www.juiceanalytics.com/writing/five-features-effective-filters/</a></p>

## Happy Dashboarding!

Part 3 of our guide has been about giving you practical advice for laying out your dashboard and presenting the information in charts and tables. In this paper we've addressed these topics:

- How to organize the dashboard page for a clean, stylish layout
- Choosing and using colors to your advantage
- A simple font framework for attractive text
- Picking the right chart for your data
- Designing easy to understand charts
- Tips for advanced visualizations and functionality

This is the final part in our guide to dashboard design. We hope you've found it useful. Please send us feedback so we can continue to refine our best practices for building dashboards people love to use.

If you liked what you read, you might be interested in downloading a PDF version of our **Designing Dashboards poster**. Just go to: <http://www.juiceanalytics.com/poster/>