Dashboard Design
for at-a-glance monitoring

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Business dashboards were inevitable.

But are they giving us the clear view that we need?

Given our love for the automobile in America, I suppose it was inevitable that something called a business dashboard would eventually emerge. This did not occur without precedent. In many respects, the dashboard is the rebirth of the Executive Information Systems (EIS) of the 1980s, which never quite got off the ground. Following that, in the 1990s, the introduction of the Balanced Scorecard by Kaplan and Norton, with its emphasis on key performance indicators (KPIs) as a means to measure what's going on in the business opened the door for the dashboard display. What really boosted the popularity of dashboards in the early 21st century, however, was the Enron scandal in 2001, which made companies desperate for new ways to monitor the business and to demonstrate to their shareholders that they were in control of what was happening.

Now that they are here and have been become popular, the question that we ought to be asking is "Are they doing the job?" In other words, do they communicate what people need to do their jobs clearly and efficiently?

Dashboards are very popular.

Dashboards are extremely popular today. Everyone assumes that dashboards are useful. Like all aspects of business intelligence, however, they can be done well or they can be done poorly.

Most dashboards fail.
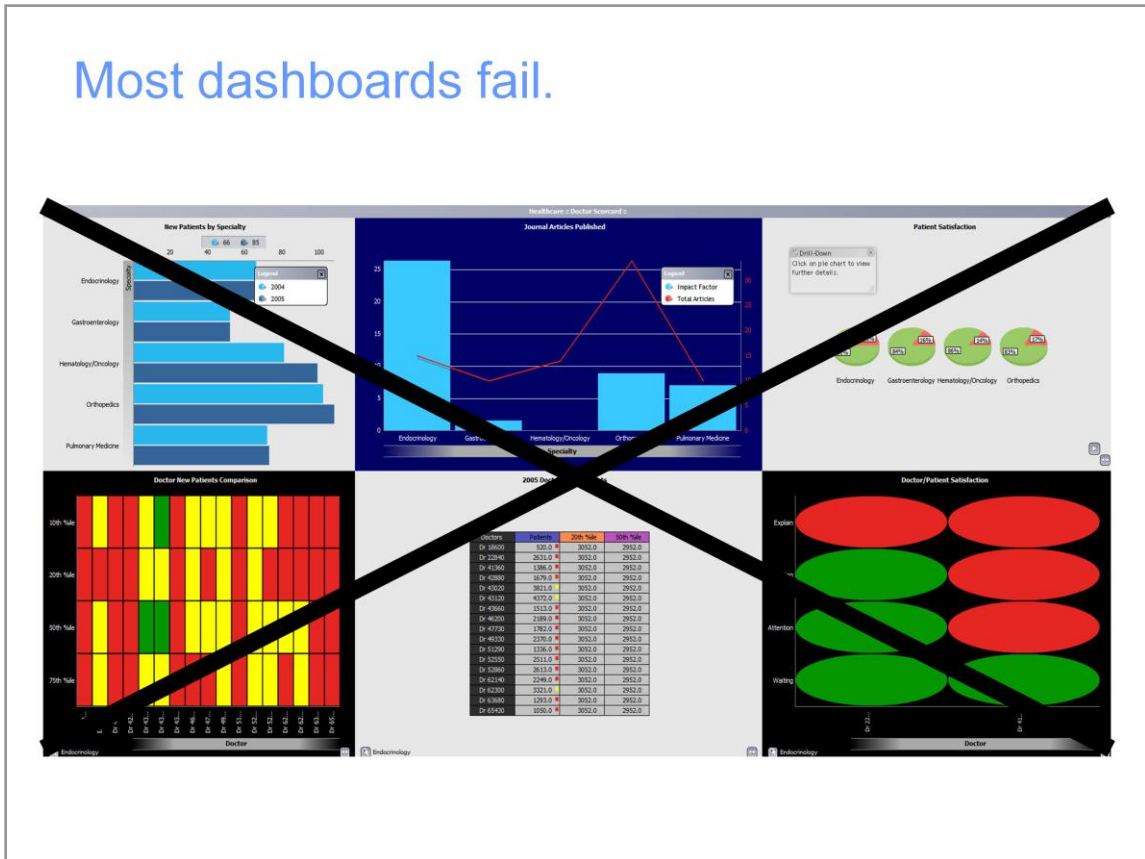
Dashboards like this are typical. You can find them on the websites of most business intelligence vendors. In their attempt to dazzle us visually, they fail entirely to present information is a way that can be understood at a glance.
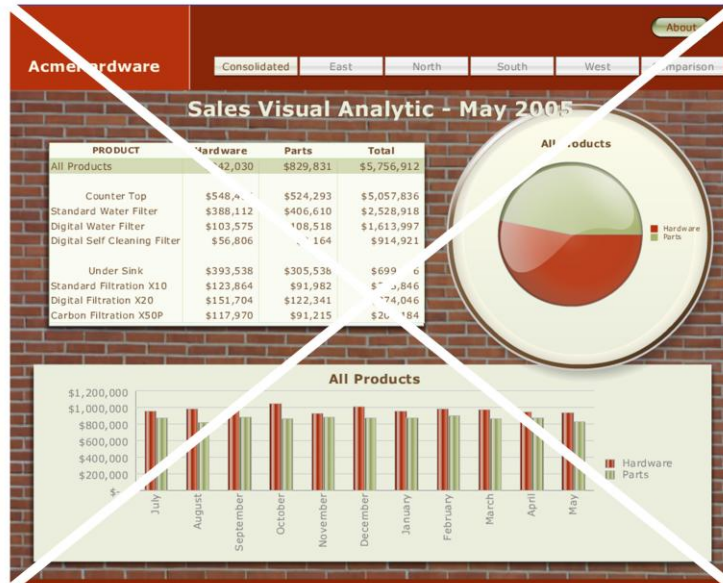
The problem with dashboards today
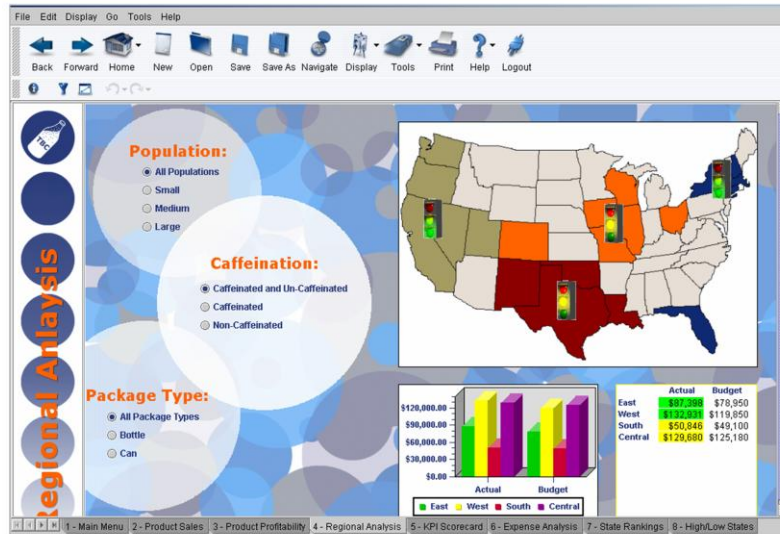
- They say too little
- What they do say, they say poorly

This failure is not rooted in technology; it is a failure of communication, rooted in poor design. The main problem that plagues dashboards today is that they don't say enough and what they do say they don't say very well. In other words, they are not very informative. When designed properly, a dashboard provides an overview of what's going on, clearly and rapidly.

Dashboards are not for show. No amount of cuteness and technical wizardry can substitute for clear communication. My purpose today is to present the design practices you cannot ignore if you wish to build dashboards that set the stage for informed response.

Dashboard definition

A visual display

of

the most important information needed
to achieve one or more objectives

that has been

consolidated on a single computer screen

so it can be

monitored and understood at a glance

Before we go any further, let's make sure we share the same understanding of what a dashboard actually is.

> *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.*

This definition first appeared in the March 20, 2004 issue of *Intelligent Enterprise* magazine in an article written by Stephen Few entitled "Dashboard Confusion."
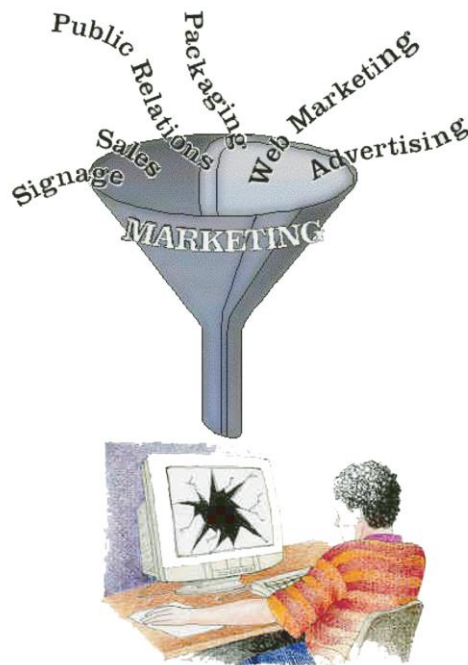
The fundamental challenge of dashboard design is to display all the required information on a single screen:

- clearly and without distraction
- in a manner that can be quickly examined and understood

Dashboards, like airplane cockpits, deserve careful design.

Think about the cockpit of a commercial jet. Years of effort went into its design to enable the pilot to see what's going on at a glance, even though there is much information to monitor. Every time I board a plane, I'm grateful that knowledgeable designers worked hard to present this information effectively. Similar care is needed for the design of our dashboards. This is a science that few of those responsible for creating dashboards have studied.

Information Dashboard Design:

The Effective Visual Communication of Data
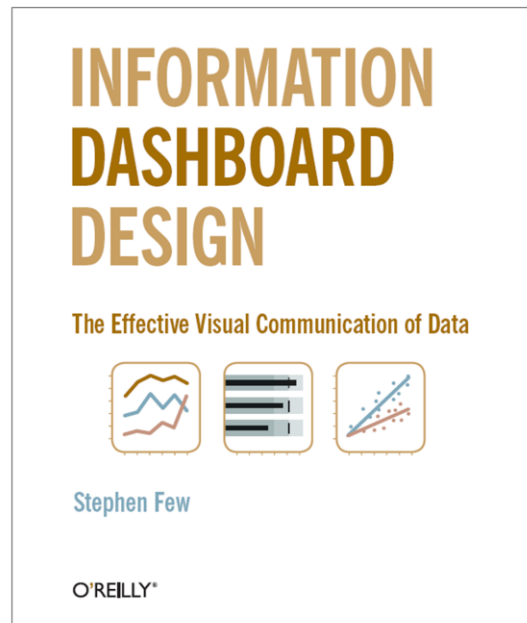
It is because of these unique design requirements that I wrote the book *Information Dashboard Design*. The principles are not difficult to learn, but they aren't obvious until someone points them out.

Dashboards must be designed to support monitoring.

Monitoring is a **unique activity**,

which requires a **unique design**.

The most important defining characteristic of a dashboard, when compared to other means of presenting information, is that it is used for **monitoring**.

Depending on your job, you might need to monitor strategic information daily (for example, an executive watching the organization as a whole or a line manager watching the work of a single department) or you might need to monitor operational information that changes from moment to moment (for example, a manufacturing floor or a telesales department). It isn't the frequency of updates to the information that determines whether you need a dashboard or some other medium of presentation, nor is it the nature of your work, be it strategic, tactical, or whatever; it is the purpose of monitoring that differentiates the dashboard.

To effectively monitor what's going on, information must be displayed in particular ways. When designed correctly, dashboards produce what Joseph Berkson once called "interocular traumatic impact": a conclusion that hits you between the eyes. When poorly designed, people won't be able to use the dashboard to maintain awareness of what's going on (something called *situation awareness*), and will soon stop using it altogether.

The task of monitoring requires immediate comprehension, often of a large body of data.

The monitoring process

1. Scan the big picture
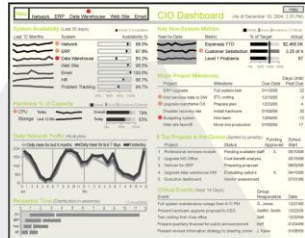
3. Link to supporting details

Last 12 Months   System   Availability %
Data Warehouse   93.2%

2. Zoom in on important specifics

Monitoring involves a series of sequential steps that the dashboard should be designed to support. The user should begin be getting an overview of what's going on and quickly identifying what needs attention. Next, the user should look more closely at each of those areas that need attention to be able to understand them well enough to determine if something should be done about them. Lastly, if additional details are needed to complete the user's understanding before deciding how to respond, the dashboard should serve as a seamless launch pad to that information.
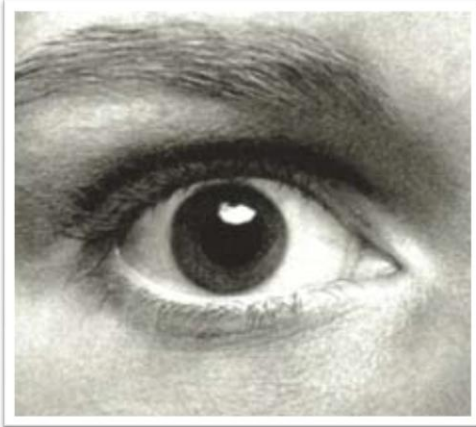
Monitoring is a cognitive activity that receives input primarily through the visual channel because this is our most powerful sense, working at high speeds of parallel input, able to detect subtle distinctions and complex patterns. Seventy percent of the sense receptors in the human body reside in our eyes.

It's sometimes appropriate to use auditory signals to get people's attention when they aren't looking at the screen, but we must make use of their eyes to perceive the rest.

The advantage of graphical communication

Metric	Variance to Target
Revenue	-0.68%
Profit	-17.90%
Avg Order Size	-5.90%
On Time Delivery	2.35%
New Customers	58.38%
Cust Satisfaction	-12.22%
Market Share	-13.33%

Text must be read, processed serially
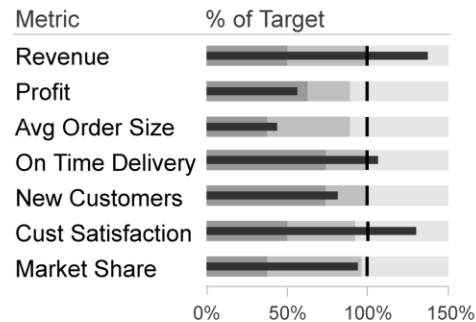
Graphics can be perceived at a glance, processed in parallel

The visual orientation of dashboards is important due to the speed of perception that's usually required to monitor information. The faster you must assess what's going on, the more you should rely on graphical means to display the information.

Text must be read, which involves a relatively slow, serial process.

Certain visual properties, however, can be perceived at a glance, without conscious thought. With the graphical display on the right, it's quick and easy to see which bars exceed target, marked by the short vertical line, and which fall short.

Words vs. pictures

2003 Call Volume (in thousands)

|	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
United States	1,983	2,343	2,593	2,283	2,574	2,838	2,382	2,634	2,938	2,739	2,983	3,493
Europe	574	636	673	593	644	679	593	139	599	583	602	690
	2,557	2,979	3,266	2,876	3,218	3,517	2,975	2,773	3,537	3,322	3,585	4,183

VS.
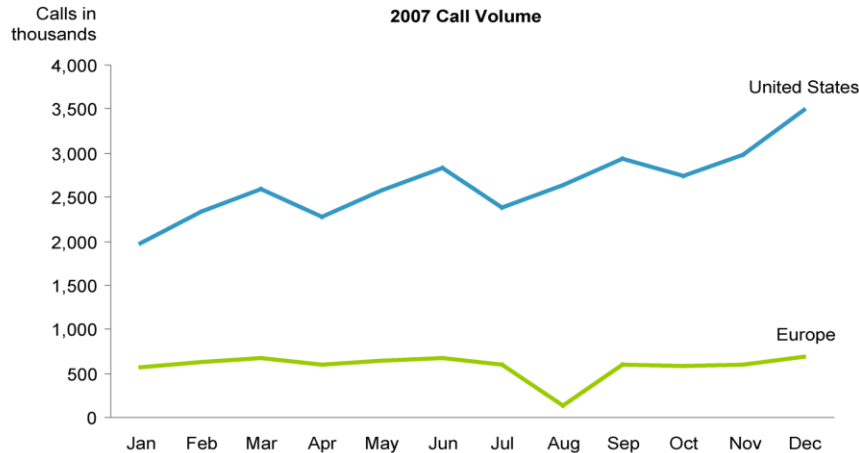
Tables provide a great means for people to look up individual, precise values, but they do not reveal patterns, trends, and exceptions in data. This line graph displays the same information that appears in the table, but in a way that brings to light several facts about sales in the United States and Europe that are not obvious in the table.

- Sales in the United States are trending upwards through the year.
- Sales in Europe are relatively flat, except for the significant dip during the month of August.
- Sales in the United States exhibit a repeating pattern of up, up, down, up, up, down, which is cyclical in nature, repeating each quarter.

Graphical representations make these facts visible by giving them shape, using visual attributes to make them available to our eyes.
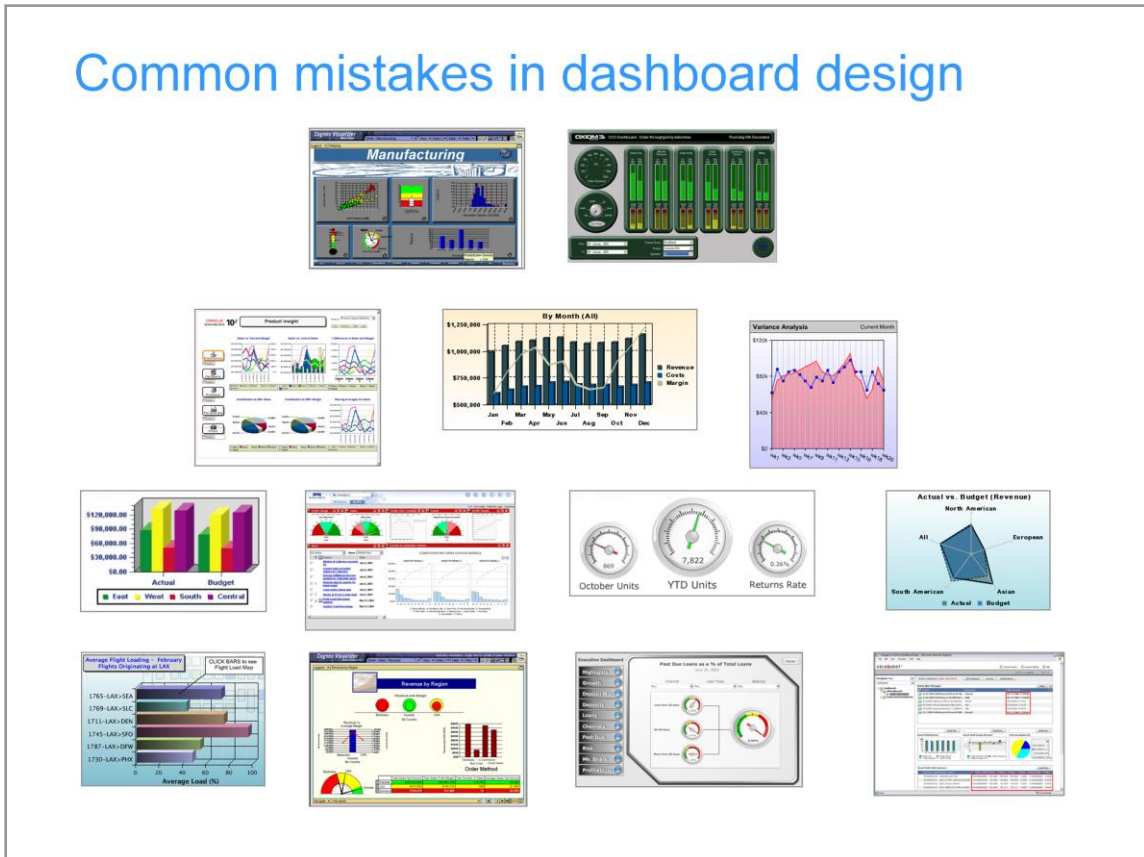
Too many dashboard vendors and designers have lost sight of the bottom line: communication. They emphasize graphical glitz over clear and efficient content. In my work with many businesses and other organizations, I have found that 13 particular mistakes are commonly made by people when designing dashboards. These mistakes undermine the ability of dashboards to communicate. Let's take a look at six of these common mistakes, one at a time.

My insistence that a dashboard confine its display to a single screen with no need for scrolling might seem arbitrary, but it is based on the findings of perceptual and cognitive research. Something powerful happens when you see things together, all within eye span. You are able to make comparisons, spot relationships, and see the big picture. This ability is lost when you must lose sight of some data in order to scroll down or over to see other data. Part of the problem is that we can only hold a few chunks of information at a time in short-term memory. Relying on the mind's eye to retain a visualization that is no longer visible is a limited venture. One of the great benefits of a dashboard is the simultaneity of vision, the ability to see everything that you need at once. This enables comparisons that lead to insights that might not occur in any other way.

The dashboard shown above not only leaves us wondering what lies below the bottom of the screen, we're also only given immediate visual access to the first of many metrics that appear at the top right, under the heading "No. of transactions". Don't force your viewers to scroll around to see what they need. I'd prefer a printed report that extends across multiple pages, because at least then I could lay out all of the pages at once for simultaneous viewing.

(Source: Website of Business Objects.)

1. Exceeding the boundaries of a single screen
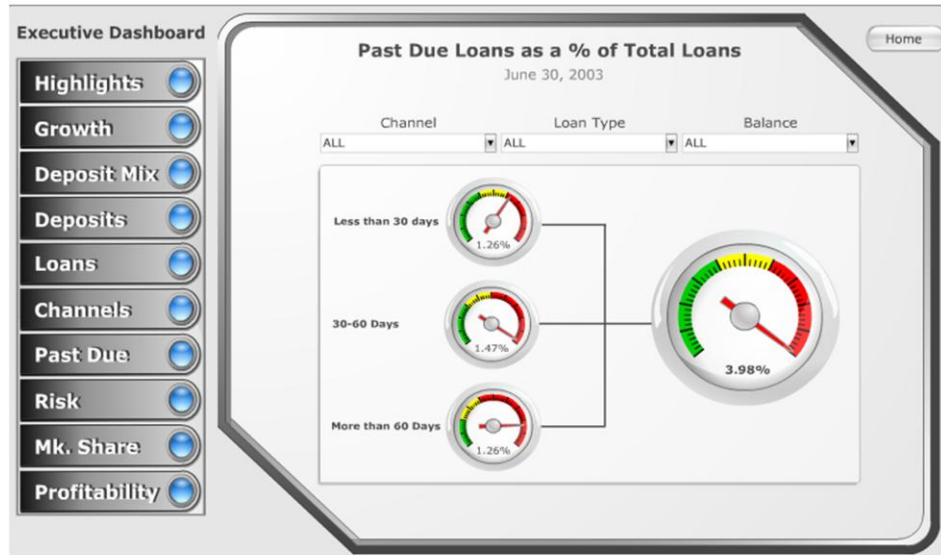
Information is often fragmented into separate screens in one of two ways:

- It is separated into discrete screens to which one must navigate.
- It is separated into different versions of a single screen that are accessed individually.

When the information should all been seen at the same time to gain the desired insights and to make the needed connections, this fragmentation undermines the unique advantages of a dashboard.

The dashboard above fragments the data that the executives need into 10 separate dashboards. This would be fine if the executives would not benefit from seeing these various measures together, but that is hardly the case. Splitting the big picture into a series of separate, small pictures is a mistake when seeing the big picture is worthwhile.

(Source: Website of Infommersion Incorporated.)

2. Supplying inadequate context for the data

869 — October Units

7,822 — YTD Units

0.26% — Returns Rate
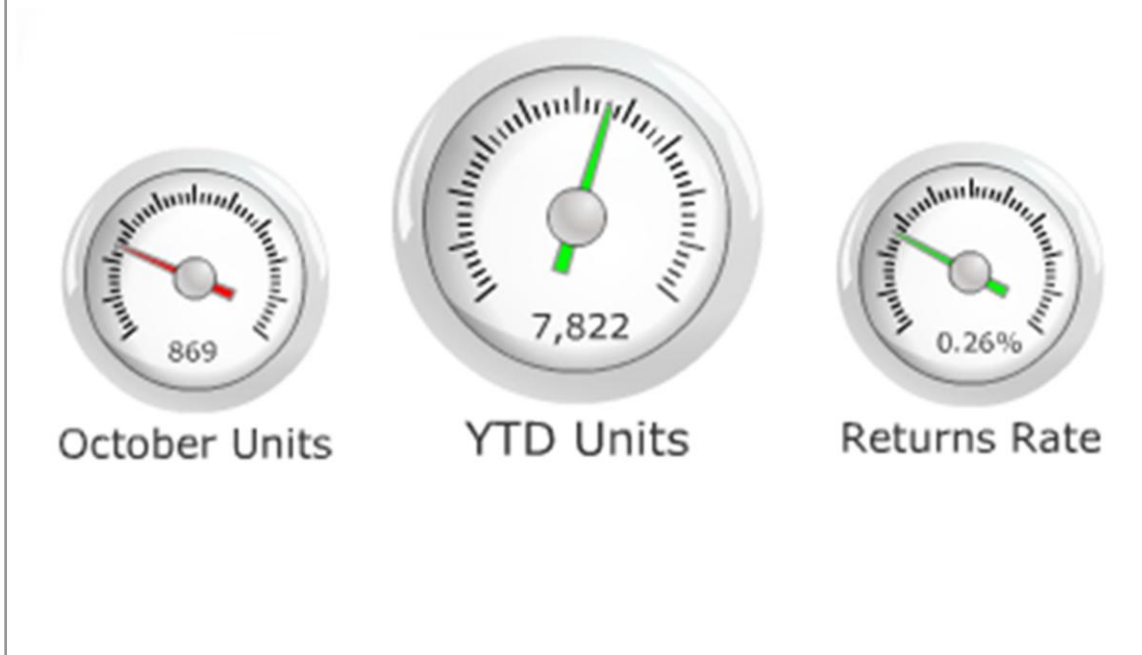
Measures of what's going on in the business rarely do well as solo acts; they need a good supporting cast to get their message across. To state that quarter-to-date sales total $736,502 without any context means little. Compared to what? Is this good or bad? How good or bad? Are we on track? Is this better than before? The right context for the key measures makes the difference between numbers that just sit there on the screen and those that enlighten and inspire action.

The gauges above could have easily incorporated useful context, but they fall short of their potential. The center gauge tells us only that 7,822 units have sold year to date and that this number is good, indicated by the green arrow.

Quantitative scales on a graphic, such as those suggested by the tick marks around these gauges, are meant to help us interpret the measures, but they can only do so when scales are labeled with numbers, which these gauges lack. A great deal of the space that is used by these gauges tells us nothing whatsoever.

(Source: Website of Informmersion Incorporated.)

Key questions that context should answer

- Are we doing well or poorly?
- How well or poorly?
- What has led to what's happening today?

Many dashboards—perhaps most—are data poor. They report numbers, but don't express them meaningfully enough for people to gain the level of understanding needed to respond. To be effective, dashboards must be data rich. This is achieved by comparing measures of what's going on to related measures (for example, to a target). When monitoring what's going on, people usually need answers to these questions:

- Are we doing well or poorly?
- How well or how poorly?
- What has led to what's happening today?

3. Choosing inappropriate display media
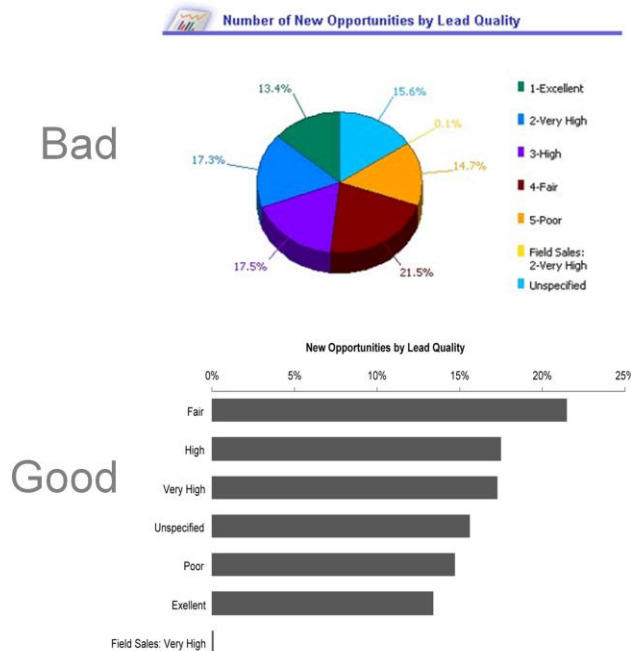
This is one of the most common design mistakes made, not just on dashboards, but in all forms of data presentation. Using a graph when a table of numbers would work better and vice versa is a frequent mistake, but the one that stands out as the most common and egregious is using the wrong type of graphic.

Without the value labels on the pie chart above, you would conclude that all of the slices are roughly the equal in size. The bar graph below it, however, tells the story clearly and quickly, because it is a better medium of display for this information.
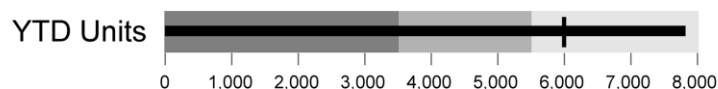
(Source: Website of Corda Technologies Incorporated.)

Display data fully and meaningfully.

- Clear display
- Clear meaning

- Appropriate medium
- Maximum relevant content

YTD Units: 7,822

Not all dashboard display widgets are equally effective. Those that work well exhibit the following characteristics:

- Clear display for efficient reading
- Clear meaning for efficient understanding
- Appropriate medium for the message
- Maximum relevant content in the space available

The gauge at the top takes up a lot of space to display a number and label. It tells you that 7,822 units have been sold year to date and indicates by the green needle (pointer) that this is good – but how good and compared to what? The simple label and number below the gauge presents the same information much more simply and in less space. If richer information is useful, the graphical display at the bottom tells the viewer more information, including 1) units sold compared to the target (the small vertical line), 2) how well unit sales are doing (sales extend well into the light gray range, which represents the good range). Also, the use of varying shades of gray (or any single hue) to define the ranges (bad, satisfactory, and good) can be read by people who are color blind.

# Example of data enrichment
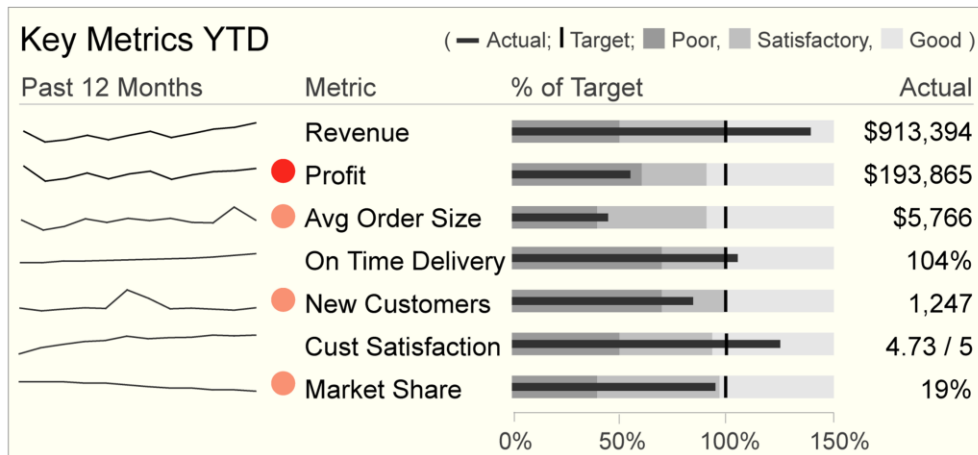
This is a portion of a larger sales dashboard. Take a moment to notice the richness of information that has been combined in a small space without sacrificing clarity.

The "Past 12 Months" data lines are called *sparklines*. They were invented by Edward Tufte. Although Tufte didn't have dashboards specifically in mind when he created them, sparklines are ideal for dashboards, but so far no dashboard vendors support them.

The graphics labeled "% of Target" are called *bullet graphs*. These are my simple invention, which were designed specifically for dashboards as an alternative to typical meters and gauges.

## 4. Ineffectively highlighting what's important
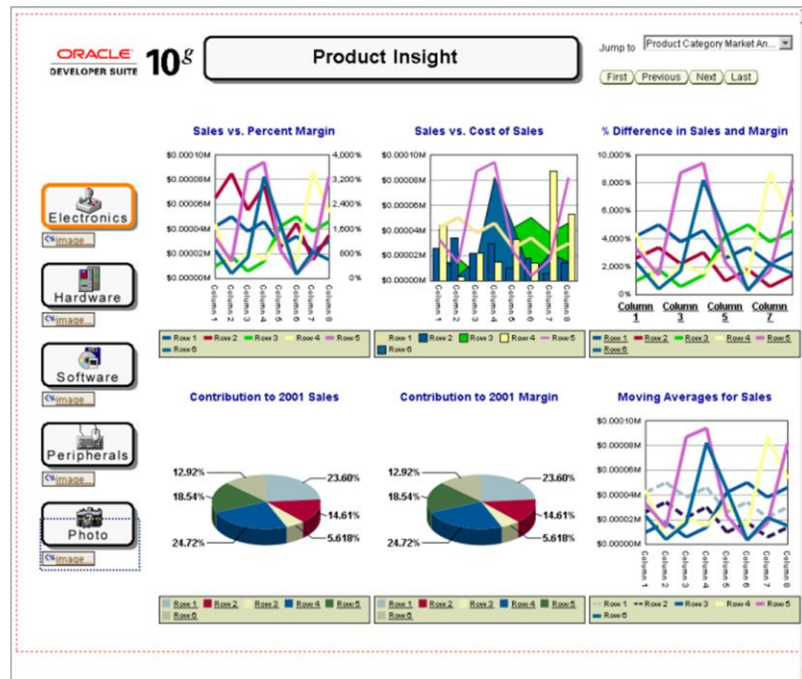
You should be able to look at a dashboard and have your eyes immediately drawn to the information that is most important. The problem with the dashboard above is that everything is visually prominent, which results in nothing standing out. The logo and navigation controls (the buttons on the left) are prominent both as a result of their placement on the screen and the use of strong borders, but these aren't data and should therefore be subdued. Then there are the graphs, where the data resides, but all the data is equally bold and colorful, leaving us with a wash of sameness and no clue where to focus. Everything that deserves space on a dashboard is important, but not equally so.

(Source: Website of Oracle Corporation.)
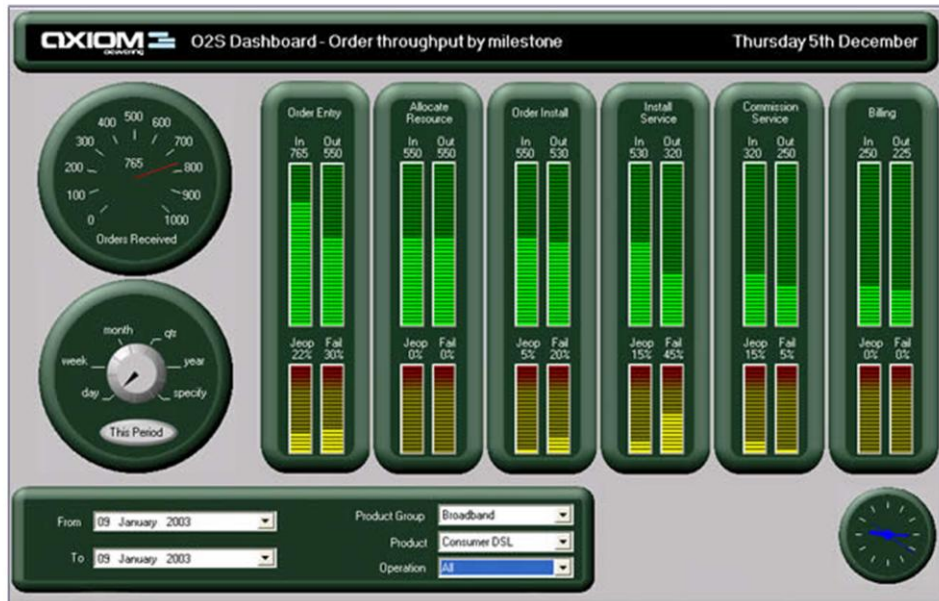
One of the most common problems on dashboards that are found on vendor websites is the abundance of useless decoration. They either hope that we will be drawn in by the artistry or assume that the decorative flourishes are necessary to keep us entertained. I assure you, however, that even people who enjoy the decoration upon first sight will grow weary of it in a short time.

The makers of the dashboard above did an exceptional job of making it look like an electronic control panel. If the purpose were to train people in the use of equipment that actually looks like this by simulating it, then this would be great, but that isn't the purpose of a dashboard. The graphics dedicated to this end are pure decoration, visual content that the viewer must process to get to the data.

(Source: Website of Axiom Systems.)

6. Misusing or overusing color
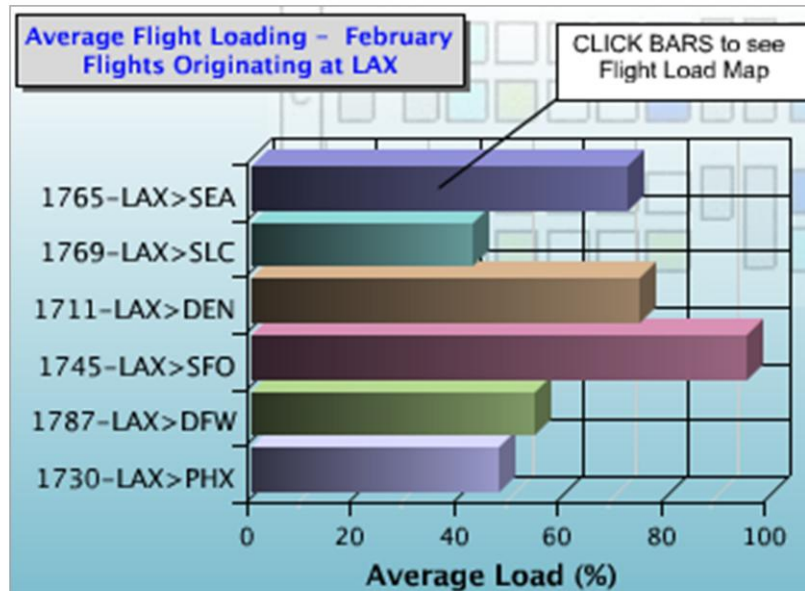
Color can be used to highlight data, encode data, and create a relationship between individual items on the screen. Color choices should be made thoughtfully, based on an understanding of how we perceive color and the significance of color differences. Some colors are hot and demand our attention while others are cooler and less demanding. When any color appears as a contrast to the norm, our eyes pay attention and our brains attempt to assign meaning to that difference. When colors in two different displays are the same we are tempted to relate them to one another.

The graph above, taken from a dashboard, misuses color in several ways, but one problem stands out as most egregious. What is the meaning of the separate color for each bar? The correct answer is that the colors mean nothing. There is no reason to assign different colors to the bars for they are already labeled along the Y axis. Nevertheless, time is wasted as our brains—whether consciously or unconsciously—search for the meaning of these differences which isn't there. It is best to keep colors subdued and neutral, except when you are using color to highlight something as especially important.

(Source: Website of Corda Technologies.)

Understand the uses and limitations of color.

Normal color perception

As seen by someone who is color blind
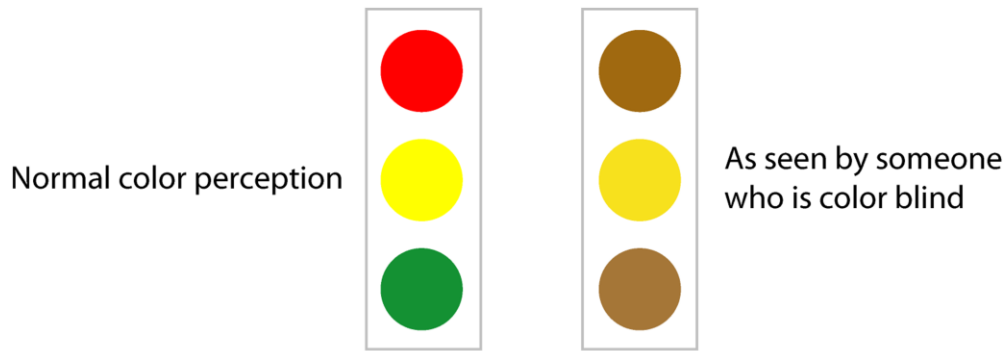
We merrily assume that we can use colors like red, yellow and green to assign important meanings to data, but in doing so we exclude the 10% of males and 1% of females who are colorblind.. Despite this fact, many vendors actually promote the use of red, yellow, and green stoplight colors as "business intelligence" colors, the most unintelligent choice.
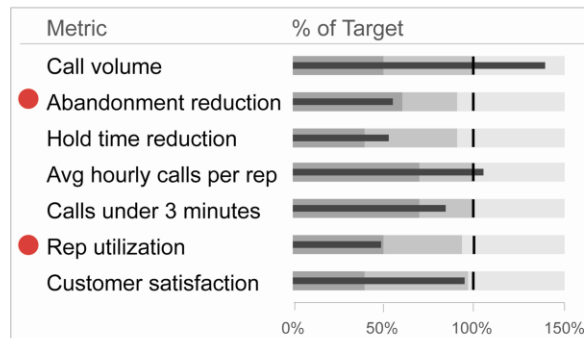
Here on the right you can see how the red, yellow, and green stoplight colors appear to someone who is colorblind. The red and the green look the same. If you can't tell the colors apart, they are useless, they fail to communicate.
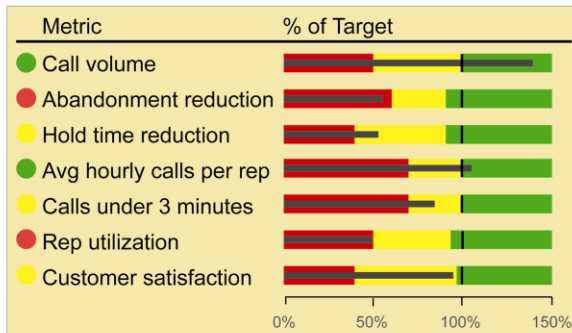
People tend to overuse color on dashboards, assuming that the brighter and more colorful they are, the better they work, but the opposite is true. People who understand color and how it can be used to display information use it sparingly.

Too much color is visually overwhelming; it tires our eyes. Also, if you use color gratuitously, you undermine its ability to be used to make things stand out. Notice how the red alerts clearly stand out in the bottom display in contrast to the neutral grays and blacks that been used elsewhere, rather than being lost in the meaninglessly colorful display above.

The key to effective dashboard design

Eloquence through simplicity

To clearly present everything on a single screen, even the slightest lack of organization will result in a confusing mess. You must condense the information, you must include only what you absolutely need, and you must use display media that can be easily read and understood even when they are small, which is often necessary.

Elegance in communication can be achieved through simplicity of design. Too often we smear a thick layer of gaudy makeup on top of the data in an effort to impress, rather than to communicate the truth in the clearest possible way.

"Simplify, simplify, simplify."

Henry David Thoreau