Dashboard Design for Real-Time Situation Awareness

Stephen Few, author of *Information Dashboard Design*

Few if any recent trends in business information delivery have inspired as much enthusiasm as dashboards. When they work, they provide a powerful means to tame the beast of data overload. Despite their popularity, however, most dashboards live up to only a fraction of their potential. They fail, not because of poor technology—at least not primarily—but because of poor design. The more critical that information is to the well being of the business, the more grievous is the failure, because the remedy is so readily available.

The term "dashboard" refers to a single screen information display that is used to monitor what's going on in some aspect of the business. The key word is "monitor." A dashboard presents the key data that you must efficiently monitor to maintain awareness of what's going on in your area of responsibility. Most dashboards are used to monitor information once a day, because more frequent use is unnecessary given the rate at which the information changes and speed at which responses must be made. Some jobs, however, require constant monitoring in real time, or close to it, because the activities that you track are happening right now and delays in responding can't be tolerated. There is perhaps no better example of this type of dashboard than one that monitors the brisk and sometimes harried activities of a call center.

Much like air traffic control systems or cockpits in airplanes, call center dashboards must be designed to support real-time "situation awareness." They must grab your attention when it's needed, they must make it easy to spot what's most important in a screen full of data, and they must give you the means to understand what's happening and respond without delay. To do this, they require expert visual design and must express measures of performance clearly, accurately, directly, and without distraction.

I've written an entire book about the visual design of dashboards in general, entitled *Information Dashboard Design: The Effective Visual Communication of Dat*a. My purpose in this white paper is not to repeat in summary form what I've already done, but rather to narrow and sharpen my focus on the specific design requirements of dashboards that are used to maintain real-time situation awareness. I am approaching this task with an eye on call center monitoring as an example of how the principles and practices that I advocate can be applied to solve a real-world challenge.

Situation Awareness

Although not all situations require ongoing moment-to-moment awareness, the term "situation awareness" is normally reserved for situations that do. There is an excellent

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book about situation awareness and how to design systems to support it entitled *Designing for Situation Awareness*. It defines the term as follows:

> *Basically, situation awareness is being aware of what is happening around you and understanding what that information means to you now and in the future. This awareness is usually defined in terms of what information is important for a particular job or goal. The concept of situation awareness is usually applied to operational situations, where people must have situation awareness for a specified reason, for example in order to drive a car, treat a patient, or separate traffic as an air traffic controller.*
>
> *(Mica R. Endsley, Betty Bolte, and Debra G. Jones, **Designing for Situation Awareness: An Approach to User-Centered Design**, 2003, Taylor and Francis, New York, page 13)*

This term was first used in relation to military pilots, when aviation was still relatively new and the ability of pilots to keep track of what was going on around them was a matter of life or death. As the definition above suggests, this involves three levels of awareness:

1) the perception of one's environment,
2) comprehension of its meaning, and
3) the projection of that understanding into the future to anticipate what might happen.

A dashboard that is designed to support situation awareness must support all three levels of awareness. Failure in any of these areas will undermine the effectiveness of the dashboard. The entire weight of responsibility for the success or failure of the dashboard, however, does not fall on the dashboard alone. The person who uses the dashboard must thoroughly understand the domain. She must have already constructed a mental model of the domain into which the information derived from the dashboard can be rapidly integrated. A perfectly designed dashboard will not overcome her lack of expertise, and her expertise cannot overcome the failures of the dashboard to present information in a way that matches her mental model.

Why Dashboards?

When they are properly designed, dashboards can provide a powerful means to monitor what's going on at a glance. Two characteristics of a dashboard are largely responsible for this ability:

- Their visual nature
- The way they integrate everything you must keep track of, however disparate, onto a single screen

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The Power of Visual Perception

Despite the richness of our sensory abilities, spread across five wonderful senses, all of which I immeasurably cherish, we perceive the world primarily through our eyes. Of all the sense receptors in the human body, 70% reside in the retinas of our eyes. There is such an intimate connection between what we see and how we think, we actually use the expression "I see" as a substitute for "I understand." When we make sense of something, we refer to what we've learned as "insight."

Vision not only dominates our senses by sheer numbers, it is also faster, based on bandwidth of input, and richer. Unless you are visually impaired, an auditory presentation of the same information that resides on a dashboard would take much longer to input, and after listening to it all, your understanding of the information would never come close to the picture that takes shape in your mind when it is communicated visually. And I'm not talking about a dashboard that takes the same words that could be spoken and presents them as text on the screen. Although delivered through the visual channel, the medium of expression is still verbal, based on language, rather than images. Any dashboard will include words, which are the best or only way to communicate many concepts, but the more that you can rely on images to tell the story, the faster that story can be perceived. We perceive images in a parallel manner (lots of information all at once), which is much faster than the serial perception of language.

The old saying that "a picture is worth a thousand words" is absolutely true when the information can be expressed as an image and the image clearly represents the information. For example, look at the table in Figure 1 of call volumes for two call centers across 12 months.

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

Figure 1: A tabular display of call volume data.

Even though this table only presents 24 values, reading them takes time and translating them into a picture of how these values compare and how they change through time is difficult.

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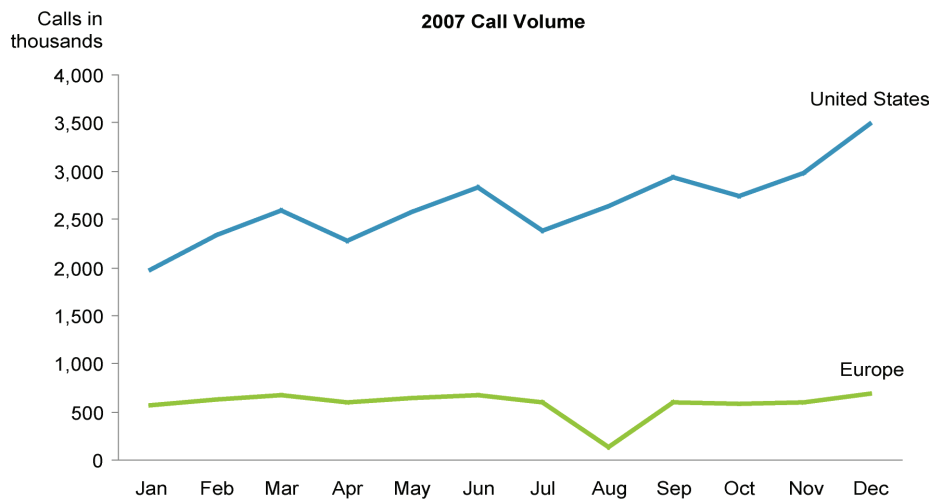Now, in Figure 2, here's the same exact information displayed as a simple line graph.

Figure 2: The same call volume data as before, but presented in a way that brings patterns, trends, and exceptions to light.

You can immediately and with little effort perceive a great many facts about call volume that jump out at you from this graph and you can hold the picture in your head if you wish. This is the power of visual perception. Whenever the information can be presented on a dashboard in graphical form, we should grab the opportunity.

To do this effectively, you must understand a bit about visual perception and cognition: how we see and how our brains make sense of what we see. This is not the place to go into this topic, but rest assured that you don't need to be a scientist to learn the simple lessons about visual perception that are required to become an accomplished dashboard designer.

The Benefits of Bringing Information Together Within Eye Span

One of the reasons that visual representations of information are so useful for understanding is that they help us work around a fundamental limitation that is built into each one of our brains. Although we have tremendous long term memory capacity, short term memory (a.k.a., working memory) is extremely limited. Short term memory is the temporary place that information is stored for immediate access while we're thinking about things. Information gets into short term memory in two ways: 1) from our senses (such as our eyes), and 2) from long term memory. When you are thinking about something that you are experiencing at the moment in the world, such as a presentation that you're listening to, selected information that you hear moves into short term memory for a moment, and as you consider it, you might draw on past memories that seem related in some way, bringing them into short term memory

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briefly to assist in the thought process. You might find it surprising to know that short term memory can only hold approximately four chunks of information at any one time. A chunk of information is the amount that you can store in a single slot of memory. If you are reading a table of numbers, such as the one in Figure 1, once you take your eyes off of it, at most you will only remember four or five of the numbers, one per slot of memory. If, however, you look at the line graph, you can store the entire pattern formed by the shape of a line (that is, 12 monthly values) as a single chunk of memory. When quantitative information is displayed in visual form in a simple manner that we can easily see and in a way that meaningfully represents the values, such as a line that goes up and down to represent the rise and fall of values through time, we can store much more information within the confines of short term memory than we could if the values were written as numbers. Simply by encoding information visually, our ability to think about it can be significantly expanded by making more of it available at any one moment.

By placing all of the information that you need to monitor (at least at a high level) on a single screen, simultaneously available to our eyes, we work around the limitations of short term memory by reducing the need to rely on it. If the information is right there in front of your eyes in the form of a dashboard, the dashboard serves as an external form of memory. You don't need to memorize the information (that is, to move it into long term memory where it will remain for years), because it's right there in front of your eyes, where it can be rapidly moved in and out of short term memory at lightning speed as you make sense of it. Ideally, you want the dashboard to include everything that you need to monitor for rapid processing.

Design Problems You Should Avoid

It is worthwhile to note some of the most common and costly problems that you should avoid when designing a real-time operational dashboard. Let's look at the following problems, one at a time:

- Too much complexity
- Too many alert conditions
- Alerts that cannot be differentiated
- Overwhelming visuals
- Distracting visuals
- Inappropriate visual salience
- Mismatch between information and its visual representation
- Indirect expression of measures
- Not enough context

Too much information or complexity

Most dashboards can display a great deal of information without overwhelming those who use them due to excessive information or complexity. Real-time dashboards that must be monitored frequently and responded to quickly at a moment's notice, however, must be somewhat simpler. I'm not suggesting that you display only a handful of items on the dashboard—it's amazing how much information we can quickly assimilate from a properly designed dashboard—but the high level of information density that works quite well for dashboards that people view once a day and respond to without urgency would exceed the practical perceptual limits of real-time monitoring.

Aside from the amount of information, the level of complexity that works on a dashboard depends entirely on the expertise of those who use it. A chart that would overwhelm and confuse some people might seem simple to others, because it's familiar and they know what to look for. In other words, appropriate boundaries for the level of complexity cannot be established arbitrarily or generally; where the lines are drawn depends entirely on the audience.

Don't display more information on the dashboard than the amount that can be quickly scanned and understood. How much is too much depends a great deal on how you present it. I've seen displays that could not be scanned and understood in any amount of time, even though they contained no more than a handful of measures, because they were poorly designed. If a chart is difficult to read, no reduction in the amount of information will change that fact, but when properly designed, 10,000 values can sometimes appear in a single chart in a way that is easy to read and understand.

Too many alert conditions

When's the last time you paid any attention to a car alarm other than to get annoyed. If alarms go off often but rarely require a response, people soon learn to ignore them. Because the conditions that set off car alarms have always been too liberal, mostly through ineffective design, they rarely serve their intended purpose. Be conservative when determining the conditions that trigger alarms. Don't demand immediate attention to circumstances that can wait.

Only use visual or auditory means to draw attention to information that urgently requires a response. If things are fine, you don't need to draw attention to the fact. For example, I've seen many dashboards that use color coding to score every single item on the dashboard as good, satisfactory, or bad. When this is done, the abundance of color makes the few items that really need attention much harder to pick out from the rest. The counter-effect of crying wolf too often is so fundamentally true and

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recognized, that it has found its way into folklore. It's a lesson worth heeding.

Alerts need not be restricted to conditions that are bad; they can be used to highlight especially good conditions also. What determines that attention is required is not whether something is bad or good, but whether or not it requires a response.

Alerts that cannot be differentiated

No colors are used more often in dashboards to assign qualitative assessments to data than green, yellow, and red. Despite how prolific they are, they serve the purpose poorly, because 10% of males and 1% of females cannot distinguish between green and red due to color blindness. The only reason that traffic lights work for people with this perceptual deficiency is because their meanings are redundantly encoded by their position: top for red, middle for yellow, and bottom for green.

The following image illustrates how red, yellow, and green look to most people who are color blind.

Normal color perception   As seen by someone
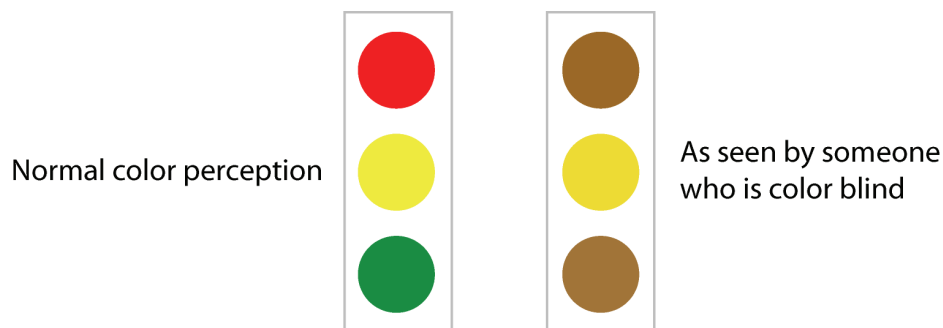   who is color blind

Figure 3: Traffic light colors, which are often used on dashboards, and how they are seen by most people who are color blind.

As you can see, this particular combination of colors is one you should avoid on a dashboard if particular colors are meant to convey particular meanings.

As I've already mentioned, it's a mistake to qualitatively encode too many items on a dashboard, because the abundance of colors makes it harder to spot the exceptional items that really need attention. If possible, stick with a single visual means to draw attention to particular items on the dashboard, such as a simple icon like the red circle in figure 4.

Figure 4: Something as simple as a red dot can work effectively as an alert if colors are used sparingly and red is only used for this purpose.

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On a real-time dashboard for situation awareness, use no more than two types of alerts at most. Rather than using different hues to differentiate them, if you use a single hue but vary its intensity from light to dark or pale to bright, even someone who is color blind will have no problem distinguishing them.

Figure 5: Variations in the intensity of a single hue are seen as different even by people who are color blind.

Overwhelming visuals

There is a prevalent problem that's associated with the use of color on dashboards: there is often too much of it. People who are experts in the use of color for graphical communication tend to use it sparingly. Too many colors or colors that are too bright are visually overwhelming, resulting in displays that are hard to look at. This is definitely not the reaction that we want to create.

Use differences in color only to indicate differences in data and only when some other visual means would not work as well. For example, if the information on your dashboard naturally falls into four different groups, you could use a different color in the background of each section to delineate them, but light borders or perhaps even white space alone will do the job without an unnecessary abundance of color.

The best use of color on a dashboard is for making particular items stand out from the rest. For example, if red dots like the one in Figure 4 appear next to items that require attention, assuming that the color red hasn't been used elsewhere and that the general tone of the dashboard is neutral in color, those items can be spotted without even thinking. Notice how much easier it is to isolate the items that need attention in the display on the right of Figure 6 versus the same items in the display on the left.
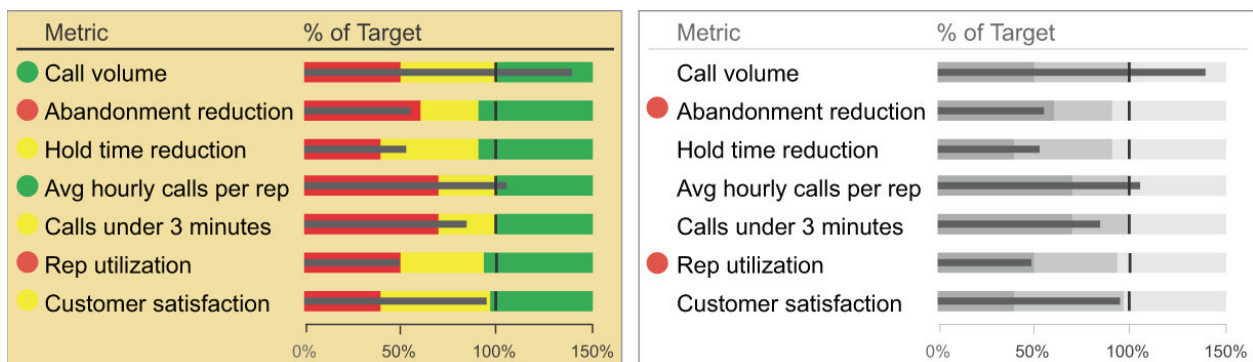

Figure 6: By using color sparingly you can use it more effectively.

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Distracting visuals

Partly due to their visual nature, people have a tendency to dress dashboards up with all sorts of visual nonsense. Any visual content that doesn't express data or isn't necessary to support the presentation of data in some useful way, however, is a distraction. Dashboards are not an appropriate venue for artistic expression; they are displays that we use to monitor important information. This information should stand out clearly without competition.

Figure 7 shows an example of a dashboard that has been dressed up to look like something that it's not: some sort of electronic control board.
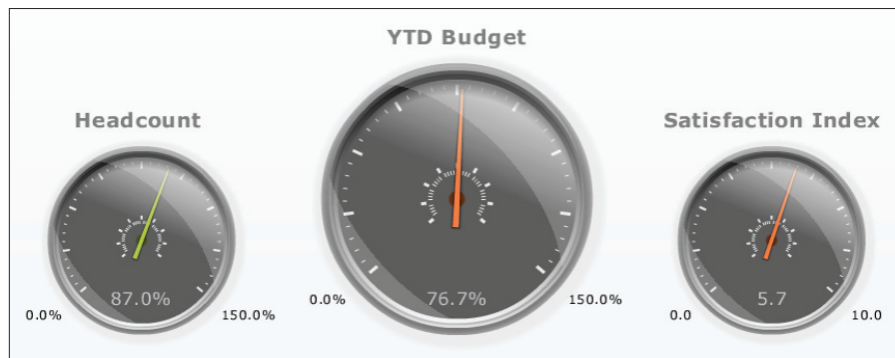

Figure 7: Excerpted from an advertisement for Crystal Xcelsius.

Notice how much care has been put into making this display look like an actual dashboard, down to the glare of sunshine on the surface of the gauges, which makes you squint to read them. When we encounter glare in the real world, we find it annoying, so what possible purpose could it serve on a computer display? This sort of graphical design, which requires talent, is suitable for video games and training simulators, but not for information dashboards.

Strive to display each piece of information in the way that communicates directly, clearly, accurately, efficiently, and comprehensively. In the same space that these gauges take up, you could present many times the information, much more effectively.

Inappropriate visual salience

All information that deserves space on a dashboard is important (or ought to be), but not all information is of equal importance. On a call center dashboard, some items of information are probably always more important than the rest. For example, of all the measures of performance that you track, perhaps the three most important are current call hold time, call duration, and the abandoned call ratio. Because they're so important, they deserve a prominent location on the dashboard, and perhaps even

more to make them stand out, such as a dark border surrounding them.

Other items might not be of great importance in general, but could be of utmost importance at any one moment, because something is going wrong that demands attention. For example, you might not always need to know how many of your agents are currently working, but if their number drops below some critical threshold, suddenly that measure takes on immediate importance—so much so that your attention needs to be drawn to it. On such occasions, the visual salience (that is, the degree to which it stands out) should be increased in some way.

When you design a dashboard, you should think hard about the relative importance of each item of information, and control the visual salience of the information to support the relative importance of each item. You should also incorporate ways of increasing the visual salience of items when conditions demand that they stand out. If everything on the dashboard is eye-catching, the result is that nothing stands out. Items can only be effectively highlighted if you begin with a fairly neutral and balanced display, except for those few items that are always important. If you use color sparingly, relying mostly on soft, natural, and relatively neutral colors for most items, such as gray, you set the stage for using bright and dark colors to draw attention when needed.

What's visually salient in the following dashboard? Everything and therefore nothing.
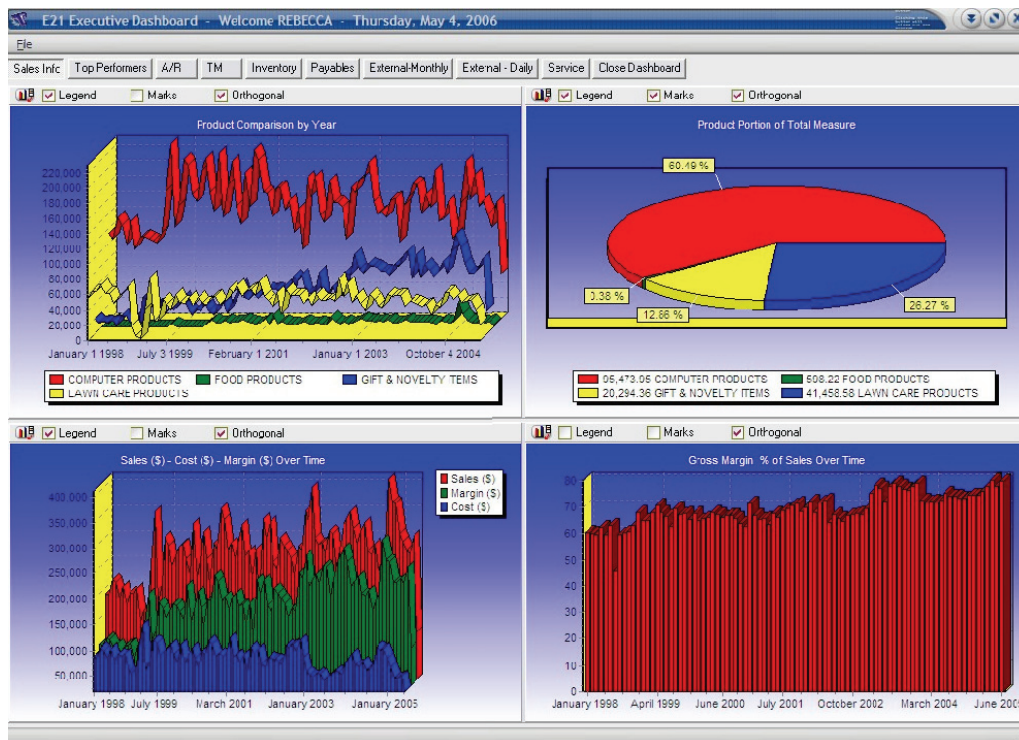

Figure 8: Sample dashboard from Technology Group International.

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Mismatch between information and its visual representation

Information and its visual representation in a dashboard often become disconnected in two ways:

- The visual medium of representation is inappropriate
- The visual representation of values does not match the values themselves

When you display information in a graph, you cannot choose any old type of graph at random. Different types of graphs are designed to display different types of information and to emphasize different features of the information. Figure 9 shows an example of a mismatch between the data and its graphical representation.

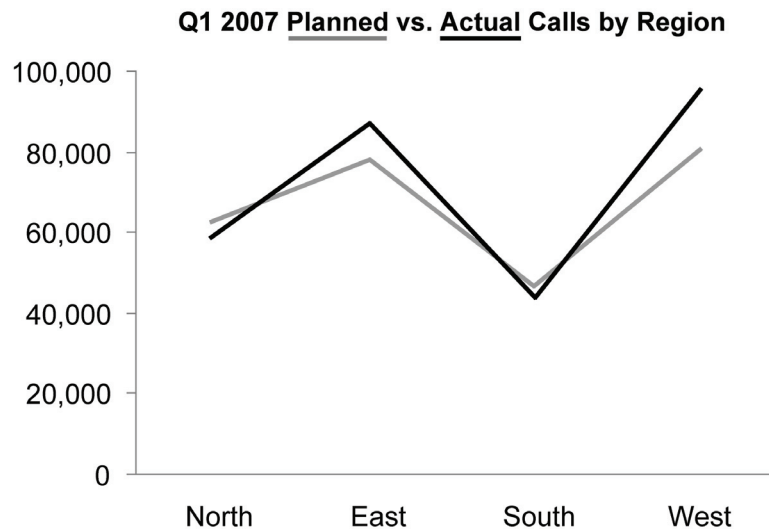**Q1 2007 <u>Planned</u> vs. <u>Actual</u> Calls by Region**

Figure 9: This graph illustrates a misuse of lines for encoding data.

Lines in a graph excel in showing change from one value to the next. They connect a series of intimately related values. More than for anything else, they are used to show the shape of change that has taken place or is expected to take place through time. In this example, however, the lines connect values that are not intimately related. The slope of a line from one value to the next does not show change; in fact, it has no meaning at all. If the lines connected values from one year to the next, a line graph would be an appropriate medium of expression for this information, but that is not the case. People using the dashboard will waste their time seeking meaning in the patterns and slopes of the lines to no avail.

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The other way that information and its visual representation are often mismatched concerns accuracy. Here's an example that is far too common.
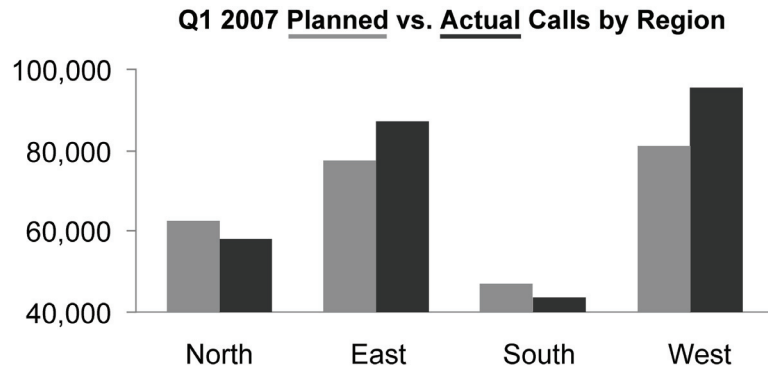
Q1 2007 Planned vs. Actual Calls by Region

Figure 10: The bars in this graph encode the values inaccurately.

Figure 10 is the same information as in the previous graph, this time displayed as a bar graph. A bar graph is an appropriate medium, but something is terribly wrong with this picture. Do you see the problem? Just in case you don't, here's the same information, this time encoded accurately.

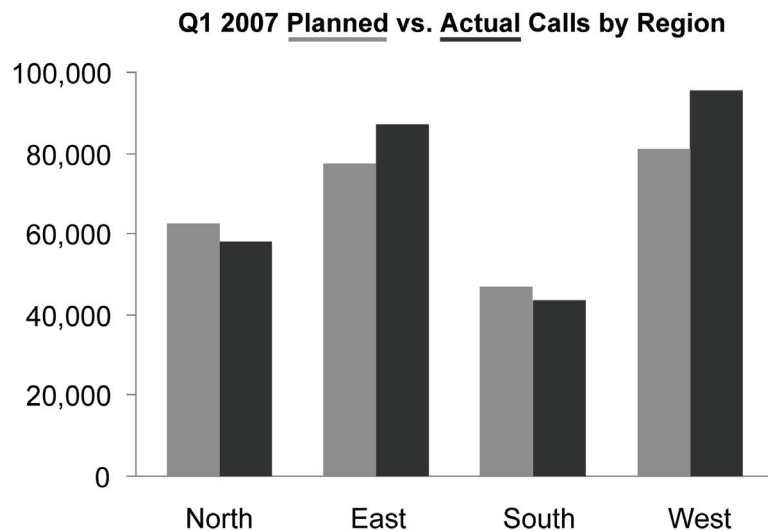**Q1 2007 Planned vs. Actual Calls by Region**

Figure 11: The bars in this graph encode the values accurately.

Notice that Figure 11 of the graph has a quantitative scale that begins at zero and extends upwards from there, but the previous version's scale begins at 40,000. It is not necessary that quantitative scales on all graphs begin at zero, but it is required of bar graphs. Only when the scale begins at zero do the heights of the bars accurately encode their relative values. When the bars begin at 40,000, actual calls in the South region appear to have only reached about 50% of the plan, but actual calls are in fact

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roughly equal to 90% of the plan. When you use a graph, the picture should tell the story. In this case, the relative heights of the bars should precisely represent the relative values.

Indirect expression of measures

Let's stick with this same example a little bit longer. If it is your purpose to monitor the performance of call volume compared to a performance target, such as the plan that is shown alongside the actuals, does the last bar graph that we've examined present this information in the most direct way possible? In fact, is does not. To determine performance to plan in a particular region, you must calculate the difference between the two bars. And if you want to understand this difference in terms of the degree of deviation from plan, you must divide the actual amount by the planned amount and subtract the difference from 1, which for the South region would produce a value of approximately -.1 or -10%. In a dashboard, if the purpose is to track performance, why not express the percentage deviation from plan directly? If you did, Figure 12 is how it would look.

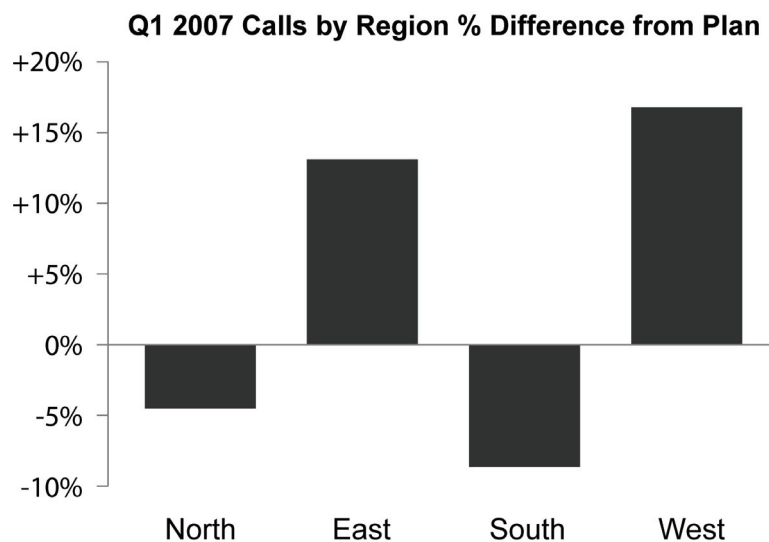**Q1 2007 Calls by Region % Difference from Plan**

Figure 12: This graph displays performance more directly than the previous graph in Figure 11.

On a dashboard, especially one that is used for real-time monitoring, you must determine how people will use information and then present it in the way that supports that use most directly.

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Not enough context

Numbers all by themselves aren't very helpful for monitoring performance. To be useful, they must be seen in context. By this I mean that they must be compared to other related numbers, such as a target, the same measure a year ago, or historical measures at equal intervals of time (for example, monthly) leading up to the present. Many dashboards fail by providing too little context for making sense of the numbers that they present. Figure 13 shows a typical example.
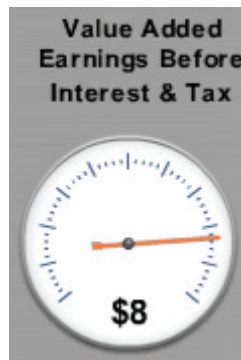

Figure 13: This gauge provides no context whatsoever for understanding this measure. (Source: www.AnalysisFactory.com)

This gauge appears on a dashboard that was designed for monitoring supply chain performance. It tells us one thing and one thing only: value added earnings before interest and tax is $8.00. That's it. The position of the needle in this gauge means nothing, because there are no values to label the scale. The next example, Figure 14, from the same dashboard provides a bit more context.

Figure 14: Even though this gauge provides qualitative context through the use of colors (assuming you are not color blind), in most cases this is still not enough. (Source: www.AnalysisFactory.com)

This time we can tell that the total cost (percentage of sales) is 15% and that this is satisfactory. This is useful for performance monitoring, but even this is rarely enough. At what percentage would the total cost be considered bad? We can't tell, because once again the quantitative scale is not labeled. Based on what standard is 15% satisfactory? Compared to a target perhaps? If so, what is the target value? How are

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we doing compared to last month or last year? Is how we're doing today part of an upwards trend, a downwards trend, or perhaps erratic ups and downs? Any context that will help the person viewing the dashboard determine whether or not action needs to be taken should be included. Yes, if the needle were pointing to the red region of the gauge, perhaps this dashboard allows you to click on the gauge to get additional information, but why make this extra step necessary if this information can be included on the dashboard in a manner that does not complicate its use?

In the following example, the same cost as a percentage of sales data that was anemically displayed in Figure 14 has been displayed more meaningfully.
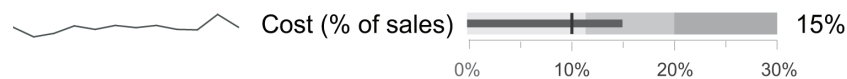

Figure 15: This display includes a great deal of context to make the information more meaningful and therefore useful. With this amount of information, it would be necessary less often to go elsewhere for more.

The graphic that appears to the right of the label is called a bullet graph. Think of it as a more informative and less space-consuming replacement for a typical gauge. The dark horizontal bar represents the primary measure—in this case cost as a percentage of sales. The short dark vertical line represents a comparative measure—in this case the cost target. The varying shades of gray in the background assign qualitative ranges of performance: good on the left, satisfactory in the middle, and poor on the right. From this display we can tell not just that performance is satisfactory, but just how satisfactory it is by seeing how far into the range the bar extends. We can also see that to be considered poor, costs must be 20% or above.

The squiggly line to the left of the label is called a sparkline. It provides an abbreviated view of the past leading up to the present—in this case the past 12 months. In a glance we can see the ups and downs of costs, including the fact that last month's costs jumped way up, but have come down again in this month. I speak a bit more about sparklines a little later.

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Design Principles You Should Follow

There is more to designing a good dashboard for real-time situation awareness than simply avoiding the problems that I've cited above. Let's turn now to some of the positive principles and practices that will lead to an effective dashboard. Here's the list of principles that we'll cover:

- Use flicker and sound to grab attention
- Encourage active thinking about the data, not just passive reaction to alarms
- Don't over-automate actions to the point where people become disengaged
- Provide smooth and simple means to respond
- Provide a common picture for the whole team
- Support projections for proactive responses
- Match the mental model

Use flicker and sound to grab attention

To demand immediate attention, real-time dashboards must speak up more assertively than others. Even those who monitor real-time displays don't have their eyes trained on them at all times. For instance, call center monitoring requires vigilance, but glancing at the dashboard periodically is usually enough. The exception is when something suddenly goes wrong and a delay in responding is out of the question. At times like these, the dashboard must have the means to grab attention to the problem even if the person who relies on it is looking elsewhere or glancing absentmindedly from time to time.

When the dashboard is even peripherally within eye span, visual flicker is often enough to do the trick. By flicker, I mean that something on the screen is going off and on at a noticeable rate. A flashing alert icon will often suffice in such circumstances if flicker is reserved for only those circumstances that are truly urgent. Don't use flicker for anything but the most urgent of circumstances or else it will become distracting and so annoying that people will learn to ignore it.

When the dashboard is not within the range of vision or when more than a moment's delay is too long, an auditory alarm is required, unless the environment is too noisy for it to be heard. A distinct sound is required to separate the alarm from ambient noise, loud enough that it can't be missed.

Whenever flicker or sound is used to grab attention, be sure to provide an easy means to turn it off. If you don't, the people who use the dashboard will figure out how to disable it, thus negating its effect, even when it's needed.

Encourage active thinking about the data, not just passive reaction to alarms

Situation awareness is not well maintained by systems that people use only when alarms go off. One of the primary goals of a real-time dashboard is to maintain a level of awareness that allows you to spot potential problems before they arise. The dashboard must be designed to provide an overview of what's going on that can be used to update awareness more like a motion picture than a series of discrete snapshots.

When an alarm goes off that interrupts you while in the midst of other activities and you have not been engaged in monitoring what's going on frequently enough to maintain awareness, you will be less prepared to respond. Too much time will be required to get your bearings when action is needed.

The best dashboards for maintaining situation awareness are those that people examine frequently in a way that makes them to think about what's going on. If viewing the dashboard is nothing more than a mechanical process of scanning a series of gauges for extreme conditions, rather than using the display to assist in thinking about what's going on, it won't engage your mind at the level that's necessary to understand what's going on and respond intelligently.

Don't over-automate actions to the points where people become disengaged

This is a close cousin to the previous principle. When a system for situation awareness does all of the thinking for you, using algorithms and rules to recognize problems, and automating every response that a computer is capable of handling, humans become disengaged. This is the last thing that you want to do if you want people to maintain situation awareness.

Just because the system can do something automatically does not necessarily mean that it should. Let the computer handle calculations and highly repetitive procedural tasks, but don't use it to displace human intelligence. Make the dashboard a partner to the person who uses it, supporting his intelligence, not attempting to replace it. No matter how great the dashboard, there are times when no computer will be able to adequately or appropriately respond. At these times, you need an operator who knows what's going on because he is fully engaged.

Provide smooth and simple means to respond

When situations arise that require immediate response, systems should make it easy to respond once a course of action has been chosen. When responses are too difficult, people are tempted to second guess the need to respond.

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Monitoring call center activity requires that you interact with the people who operate the phones when action is required. If hold times are too long and the abandonment rate is rising, you need to get to the calls faster. Perhaps you need to communicate with operators who are offline to get them to get back in the action. Perhaps you need to let all the operators know the situation to encourage them to turn calls around more quickly. Perhaps you need to tell those who are falling behind to catch up. All of these potential responses require communication. An example of a "smooth and simple means to respond" in such an event might involve a mechanism built right into the dashboard for instant messaging all or selected operators with either a prewritten message or when you want to make sure they take it seriously, with a message that you've composed on the spot.

Provide a common picture for the whole team

Just as you want the person who uses the dashboard to maintain overall situation awareness, you want the entire team to share a common understanding of the situation by provided them a similar overview. This is definitely true when responses to problems require the cooperative efforts of a team.

In call centers, you certainly don't want phone operators to constantly monitor the activities of the call center as a whole; you want them focused on conversation. You do, however, want them to get see the big picture occasionally and to fully understand what you see when you use the dashboard, what it means, and why you respond how you do. The more they understand the big picture and where they fit into it, they more they will be willing and able to respond to problems or opportunities when they arise.

Support projections for proactive responses

As the definition of situation awareness suggests, a real-time dashboard should do more than display what's going on; it should do this in a way that helps people anticipate what will happen if things continue their current course. Ideally, the dashboard should help people prevent problems from occurring.

One of the best and easiest ways to support this need is by providing enough historical context for people to easily spot trends that are heading in the wrong direction. Dashboards are limited on space, so you often cannot rely on the common means such as regular line graphs to provide time-series information leading up to the present. There is an abbreviated version of line graphs, called sparklines, which were invented by data visualization visionary Edward Tufte, that serve this purpose well on dashboards. Remember the collection of metrics that were shown in Figure 6? Here

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they are again, but this time they've been enhanced with the use of sparklines.

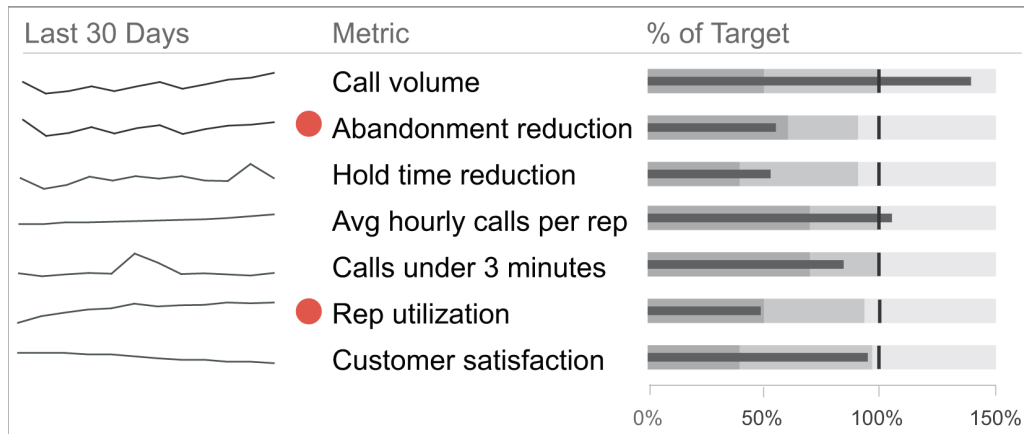| Last 30 Days	Metric	% of Target
	Call volume	
	● Abandonment reduction	
	Hold time reduction	
	Avg hourly calls per rep	
	Calls under 3 minutes	
	● Rep utilization	
	Customer satisfaction	
		0% 50% 100% 150%

Figure 16: Meaningful context has been added to these metrics in the form of sparklines, which provide a quick sense of the history that has led up to the present.

As you can see in this example, a sparkline looks like a line graph without axes, scales, and labels. Sparklines are not meant to replace line graphs, but to provide an abbreviated sense of the ups and downs of history leading up to the present in a limited amount of space. Think of them as trend arrows, but much richer in the picture of history that they provide. With the sparklines, I can see that hold time reduction performance took a dive yesterday, even though it's performing satisfactorily today. Perhaps more importantly, however, I can clearly see that customer satisfaction, even though it is currently close to target, performance has been steadily declining over the last 30 days. Even though no alarms are going off, I can tell that I need to do something to head off a negative trend.

Match the mental model

People who are experts in what they do have constructed a model in their heads to help them understand the domain. This model includes all significant players (people, things, events, etc.) and how they relate to one another, such as how they fit into the overall process and how they affect one another. To some degree, this model is actually a lot like a picture or diagram of the domain that someone might draw on paper if asked to explain it. Thinking is highly visual.

In light of this fact, the closer a dashboard is able to match this mental model of the domain that it's used to monitor, the easier it is for the person who uses it to make sense of the information and to plug the facts revealed on the dashboard into that internal model. Now, obviously you cannot take a photograph of someone's internal model and duplicate it exactly on a dashboard, but you can take the time to get the people who will use the dashboard to explain the models in their heads to you and

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then strive to display the information in a manner that emulates that model. You might even ask the experts to sketch out the domain on paper, which will serve as a good blueprint for the visual design of the dashboard.

Example of a Well Designed Dashboard for Situation Awareness

I'll conclude with an example of a sample Telesales Dashboard, which illustrates the visual design principles and practices that I've covered in this paper. If you are involved in telesales, your requirements will no doubt differ from those that this sample dashboard addresses, but it should still help you to imagine how an effective dashboard of your own might look and function.
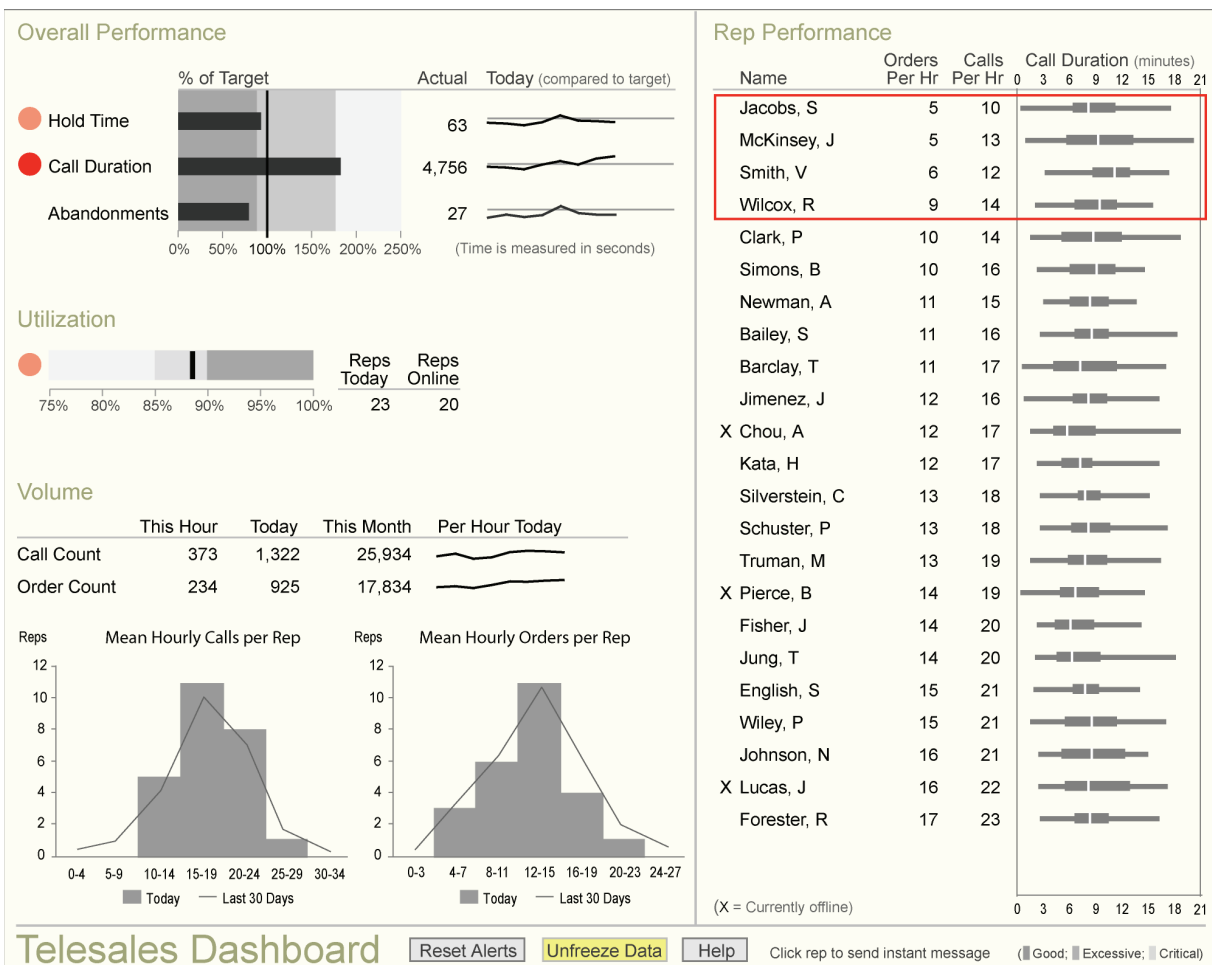

Figure 17: This sample Telesales Dashboard originally appeared in *Information Dashboard Design: The Effective Visual Communication of Data*, Stephen Few, O'Reilly Media, 2006)

Notice the following characteristics of this dashboard:

- The amount of information that it displays in not overwhelming.
- Each item of information is displayed in a way that can be quickly examined to assess performance, both in terms of an appropriate graphical medium and direct measure of performance (for example, percentage of target).
- Measures have been expressed with enough context (for example, comparisons to targets, averages, and previous periods) for their meanings to be clear.
- Because color is used so sparingly, it is easy to spot those items that require attention by scanning for red.
- The most important items have been placed in the prominent position of the screen—the upper left.
- Although the dashboard alerts the person using it to problems, it does not automate a response, but requires human intelligence to be engaged in the process and initiate responses.
- Responses can be made easily, such as by clicking on the name of a telesales representative who is performing poorly to send an instant message.
- Because the information is being updated every few seconds, when a close examination is desired, updates can be temporarily halted to remove the distraction of changing data. If updates remain frozen for too long, however, the Unfreeze Data button changes color and eventually begins to flash as a reminder.
- Only what is necessary appears on the dashboard. It is not cluttered or distractingly decorated. Even instructions for how to use it have been inconspicuously positioned (such as the legend in the lower right corner) or placed on a separate page that can be accessed by pressing the Help button.

Effective dashboards lack eye candy. They are not designed to wow people upon first sight, but to inform people with precisely what they need in the way that they need it day in and day out. This is the kind of dashboard that will actually get used and will continue to be appreciated long after the initial impression has worn off.

About Stephen Few

Stephen is the Founder and Principal of Perceptual Edge, a consultancy that specializes in data visualization for business. When information is presented to our eyes as properly designed graphics, a level of understanding can be gained and communication can occur that results in heightened awareness. Stephen provides consulting and training services, writes the monthly Visual Business Intelligence Newsletter, speaks frequently at conferences, and teaches in the MBA program at the University of California at Berkeley. He is the author of two books: *Show Me the Numbers: Designing Tables and Graphs to Enlighten* and *Information Dashboard Design: The Effective Visual Communication of Data*. You can learn more about Stephen's work at www.perceptualedge.com.

About Inova Solutions

Inova Solutions is a leading global provider of performance optimization solutions for the contact center, help desk and network operations center. Inova's products integrate data from existing systems to provide unified views of live and historical metrics across organizational levels for improved decision making and increased productivity. Superior technology, world-class services and support, and two decades of industry experience allows us to craft powerful solutions that deliver measurable results to a diverse customer base ranging from emerging growth to Fortune and Blue Chip companies. Learn more about Inova Solutions at www.inovasolutions.com.