INFORMATION DASHBOARD DESIGN
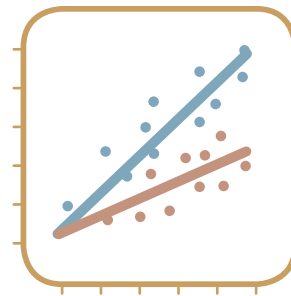
The Effective Visual Communication of Data

Stephen Few

1

CLARIFYING THE VISION

Dashboards offer a unique and powerful solution to an organization's need for information, but they usually fall far short of their potential. Dashboards must be seen in historical context to understand and appreciate how and why they've come about, why they've become so popular, and why—despite many problems that undermine their value today—they offer benfits worth pursuing. To date, little serious attention has been given to their visual design. This book strives to fill this gap. However, confusion abounds, demanding a clear definition of dashboards before we can explore the visual design principles and practices that must be applied if they are to live up to their unique promise.

Above all else, this is a book about communication. It focuses exclusively on a particular medium of communication called a *dashboard*. In the fast-paced world of information technology (IT), terms are constantly changing. Just when you think you've wrapped your mind around the latest innovation, the technology landscape shifts beneath you and you must struggle to remain upright. This is certainly true of dashboards.

Live your life on the surface of these shifting sands, and you'll never get your balance. Look a little deeper, however, and you'll discover more stable ground: a bedrock of objectives, principles, and practices for information handling that remains relatively constant. Dashboards are unique in several exciting and useful ways, but despite the hype surrounding them, what they are and how they work as a means of delivering information are closely related to some long-familiar concepts and technologies. It's time to cut through the hype and learn the practical skills that can help you transform dashboards from yet another fad riding the waves of the technology buzz into the effective means to enlighten that they really can be.

Today, everybody wants a dashboard. Like many newcomers to the technology scene, dashboards are sexy. Software vendors work hard to make their dashboards shimmy with sex appeal. They taunt, "You don't want to be the only company in your neighborhood without one, do you?"

They warn, "You can no longer live without one." They whisper sweetly, "Still haven't achieved the expected return on investment (ROI) from your expensive data warehouse? Just stick a dashboard in front of it and watch the money pour in." Be still my heart.

Those gauges, meters, and traffic lights are so damn flashy! You can imagine that you're sitting behind the wheel of a German-engineered sports car, feeling the wind whip through your hair as you tear around curves on the autobahn at high speeds, all without leaving your desk.

Everyone wants a dashboard today, but often for the wrong reasons. Rest assured, however, that somewhere beyond the hype and sizzle lives a unique and effective solution to familiar business problems that are rooted in a very real need for information. That's the dashboard that deserves to live on your screen.

All That Glitters Is Not Gold

Dashboards can provide a unique and powerful means to present information, but they rarely live up to their potential. Most dashboards fail to communicate efficiently and effectively, not because of inadequate technology (at least not primarily), but because of poorly designed implementations. No matter how great the technology, a dashboard's success as a medium of communication is a product of design, a result of a display that speaks clearly and immediately. Dashboards can tap into the tremendous power of visual perception to communicate, but only if those who implement them understand visual perception and apply that understanding through design principles and practices that are aligned with the way people see and think. Software won't do this for you. It's up to you.

Unfortunately, most vendors that provide dashboard software have done little to encourage the effective use of this medium. They focus their marketing efforts on flash and dazzle that subvert the goals of clear communication. They fight to win our interest by maximizing sizzle, highlighting flashy display mechanisms that appeal to our desire to be entertained. Once implemented, however, these cute displays lose their spark in a matter of days and become just plain annoying. An effective dashboard is the product not of cute gauges, meters, and traffic lights (Figure 1-1), but rather of informed design: more science than art, more simplicity than dazzle. It is, above all else, about communication.

Figure 1-1. A typical flashy dashboard. Can't you just feel the engine revving?

This failure by software vendors to focus on what we actually *need* is hardly unique to dashboards. Most software suffers from the same shortcoming—despite all the hype about user-friendliness, it is difficult to use. This sad state is so common, and has been the case for so long, we've grown accustomed to the pain. On those occasions when this ugly truth breeches the surface of our consciousness, we usually blame the problem on ourselves rather than the software, framing it in terms of "computer illiteracy." If we could only adapt more to the computer and how it works, there wouldn't be a problem—or so we reason. In his insightful book entitled *The Inmates Are Running the Asylum*, master designer Alan Cooper writes:

> The sad thing about dancing bearware [Cooper's term for poorly designed software that is difficult to use] is that most people are quite satisfied with the lumbering beast. Only when they see some real dancing do they begin to suspect that there is a world beyond ursine shuffling. So few software-based products have exhibited any real dancing ability that most people are honestly unaware that things could be better—a lot better.

Cooper argues that this failure is rooted in an approach to software development that simply doesn't work. In a genuine attempt to please their customers, software engineers focus on checking all the items, one by one, off of lists of requested features. This approach makes sense to technology-oriented software engineers, but it results in lumbering beasts. Customers are expert in knowing what they need to accomplish, but not in knowing how software ought to be designed to support their needs. Allowing customers to design software through feature requests is the worst form of disaster by committee.

Alan Cooper, *The Inmates Are Running the Asylum* (Indianapolis, IN: SAMS Publishing, 1999), 59.

Software vendors should bring design vision and expertise to the development process. They ought to know the difference between superficial glitz and what really works. But they're so exhausted from working ungodly hours trying to squeeze more features into the next release that they're left with no time to do the research needed to discover what actually works, or even to step back and observe how their products are really being used (and failing in the process).

The part of information technology that focuses on reporting and analysis currently goes by the name *business intelligence* (BI). To date, BI vendors have concentrated on developing the underlying technologies that are used to gather data from source systems, transform data into a more usable form, store data in high-performance databases, access data for use, and present data in the form of reports. Tremendous progress has been made in these areas, resulting in robust technologies that can handle huge repositories of data. However, while we have managed to warehouse a great deal of information, we have made little progress in using that information effectively. Relatively little effort has been dedicated to engaging human intelligence, which is what this industry, by definition, is supposed to be about.

A glossary on the Gartner Group's web site defines business intelligence as "An interactive process for exploring and analyzing structured, domain-specific information… to discern business trends or patterns, thereby deriving insights and drawing conclusions" (*http://www.gartner.com/6_ help/glossary/GlossaryB.jsp*). To progress in this worthwhile venture, the BI industry must shift its focus now to an engaging interaction with human perception and intelligence. To do this, vendors must base their efforts on a firm understanding of how people perceive and think, building interfaces, visual displays, and methods of interaction that fit seamlessly with human ability.

Even Dashboards Have a History

In many respects, "dashboard" is simply a new name for the *Executive Information Systems* (EISs) first developed in the 1980s. These implementations remained exclusively in the offices of executives and never numbered more than a few, so it is unlikely that you've ever actually seen one. I sat through a few vendor demos back in the 1980s but never did see an actual system in use. The usual purpose of an EIS was to display a handful of key financial measures through a simple interface that "even an executive could understand." Though limited in scope, the goal was visionary and worthwhile, but ahead of its time. Back then, before data warehousing and business intelligence had evolved the necessary data-handling methodologies and given shape to the necessary technologies,

the vision simply wasn't practical; it couldn't be realized because the required information was incomplete, unreliable, and spread across too many disparate sources. Thus, in the same decade that the EIS arose, it also went into hibernation, preserving its vision in the shadows until the time was ripe… That is, until now.

During the 1990s, data warehousing, *online analytical processing* (OLAP), and eventually business intelligence worked as partners to tame the wild onslaught of the information age. The emphasis during those years was on collecting, correcting, integrating, storing, and accessing information in ways that sought to guarantee its accuracy, timeliness, and usefulness. From the early days of data warehousing on into the early years of this new millennium, the effort has largely focused on the technologies, and to a lesser degree the methodologies, needed to make information available and useful. The direct beneficiaries so far have mostly been folks who are highly proficient in the use of computers and able to use the available tools to navigate through large, often complex databases.

What also emerged in the early 1990s, but didn't become popular until late in that decade, was a new approach to management that involved the identification and use of *key performance indicators* (KPIs), introduced by Robert S. Kaplan and David P. Norton as the *Balanced Scorecard*. The advances in data warehousing and its technology partners set the stage for this new interest in management through the use of metrics—and not just financial metrics—that still dominates the business landscape today. *Business Performance Management* (BPM), as it is now commonly known, has become an international preoccupation. The infrastructure built by data warehousing and the like, as well as the interest of BPM in metrics that can be monitored easily, together tilled and fertilized the soil in which the hibernating seeds of EIS-type displays were once again able to grow.

What really caused heads to turn in recognition of dashboards as much more than your everyday fledgling technology, however, was the Enron scandal in 2001. The aftermath put new pressure on corporations to demonstrate their ability to closely monitor what was going on in their midst and to thereby assure shareholders that they were in control. This increased accountability, combined with the concurrent economic downturn, sent Chief Information Officers (CIOs) on a mission to find anything that could help managers at all levels more easily and efficiently keep an eye on performance. Most BI vendors that hadn't already started offering a dashboard product soon began to do so, sometimes by cleverly changing the name of an existing product, sometimes by quickly purchasing the rights to an existing product from a smaller vendor, and sometimes by cobbling together pieces of products that already existed. The marketplace soon offered a vast array of dashboard software from which to choose.

Dispelling the Confusion

Like many products that hit the high-tech scene with a splash, dashboards are veiled in marketing hype. Virtually every vendor in the BI space claims to sell dashboard software, but few clarify what dashboards actually are. I'm reminded of the early years of data warehousing, when—eager to learn about this new approach to data management—I asked my IBM account manager how IBM defined the term. His response was classic and refreshingly candid: "By data warehousing we at IBM mean whatever the customer thinks it means." I realize that this wasn't IBM's official definition, which I'm sure existed somewhere in their literature, but it was my blue-suited friend's way of saying that as a salesperson, it was useful to leave the term vague and flexible. As long as a product or service remains undefined or loosely defined, it is easy to claim that your company sells it.

Those rare software vendors that have taken the time to define the term in their marketing literature start with the specific features of their products as the core of the definition, rather than a generic description. As a result, vendor definitions tend to be self-validating lists of technologies and features. For example, Dr. Gregory L. Hovis, Director of Product Deployment for Snippets Software, Inc., asserts:

Gregory L. Hovis, *"Stop Searching for Information—Monitor it with Dashboard Technology,"* DM Direct, *February 2002.*

> Able to universally connect to any XML or HTML data source, robust dashboard products intelligently gather and display data, providing business intelligence without interrupting work flow…An enterprise dashboard is characterized by a collection of intelligent agents (or gauges), each performing frequent bidirectional communication with data sources. Like a virtual staff of 24x7 analysts, each agent in the dashboard intelligently gathers, processes and presents data, generating alerts and revising actions as conditions change.

Mark Leon, "Dashboard Democracy," *Computerworld,* June 16, 2003

An article in the June 16, 2003 edition of *Computerworld* cites statistics from a study done by AMR Research, Inc., which declares that "more than half of the 135 companies… recently surveyed are implementing dashboards."

Unfortunately, the author never tells us what dashboards are. He teases us with hints, stating that dashboards and scorecards are BI tools that "have found a new home in the cubicles," having moved from where they once resided (exclusively in executive suites) under the name Executive Information Systems. He gives examples of how dashboards are being used and speaks of their benefits, but leaves it to us to piece together a sense of what they are. The closest he comes to a definition is when he quotes John Hagerty of AMR Research, Inc.: "Dashboards and scorecards are about measuring."

While conducting an extensive literature review in 2003 in search of a good working definition, I visited DataWarehousingOnline.com and clicked on the link to "Executive Dashboard" articles. In response, I received the same 18 web pages of links that I found when I separately clicked on links for "Balanced Scorecard," "Data Quality and Integration," and "Data Mining." Either the links weren't working properly, or this web portal for the data warehousing industry at the time believed that these terms all meant the same thing.

I finally decided to begin the task of devising a working definition of my own by examining every example of a dashboard I could find on the Web, in search of their common characteristics. You might find it interesting to take a similar journey. In the next few pages, you'll see screenshots of an assortment of dashboards, which were mostly found on the web sites of vendors that sell dashboard software. Take the time now to browse through these examples and see if you can discern common threads that might be woven into a useful definition.

By including these examples from the web sites of software vendors and a few other sources, I do not mean to endorse any of these dashboards or the software products used to create them as examples of good design, nor as extraordinary examples of poor design. To varying degrees they all exhibit visual design problems that I'll address in later chapters.

This dashboard from Business Objects relies primarily on graphical means to display a series of performance measures. along with a list of alerts, Notice that the title of this dashboard is "My KPIs." Key performance indicators and dashboards appear to be synonymous in the minds of most vendors. Notice the gauges as well. We'll see quite a few of them.
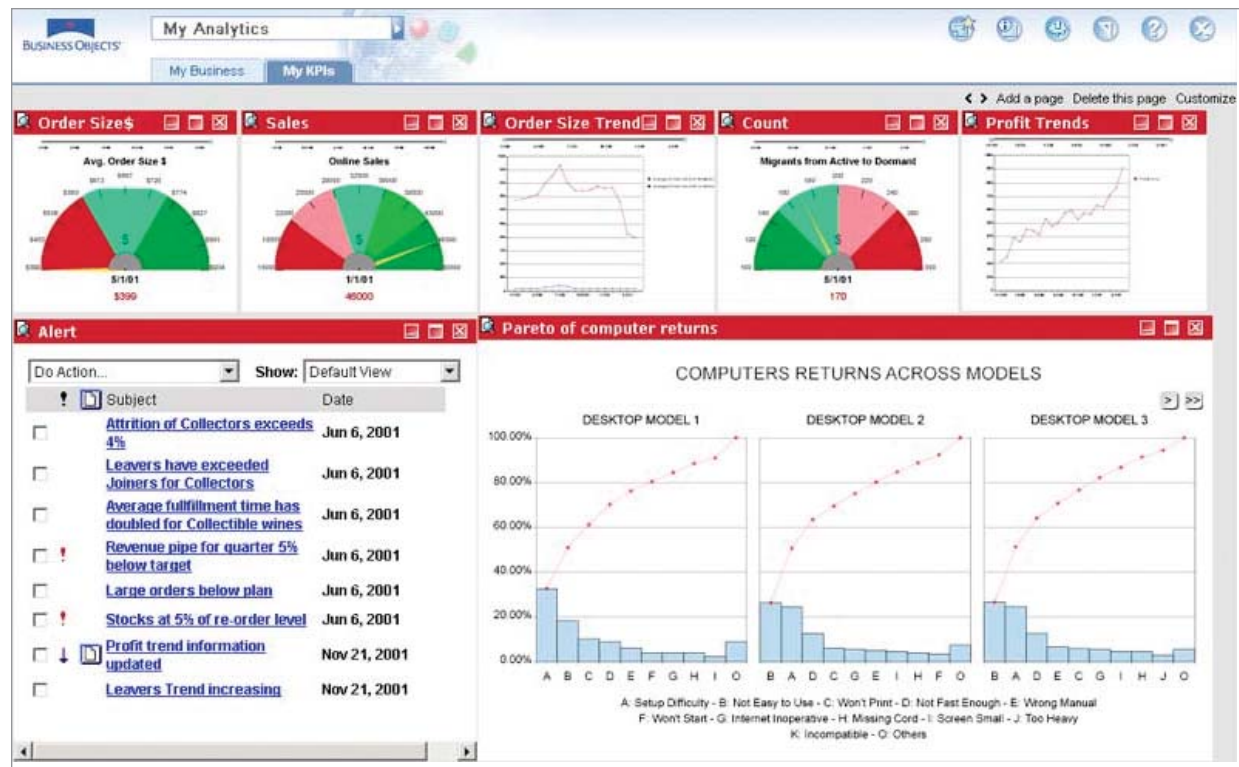
Figure 1-2

This dashboard from Oracle Corporation displays a collection of sales measures for analyzing product performance by category. All of the measures are displayed graphically. We'll find that this emphasis on graphical display media is fairly common.
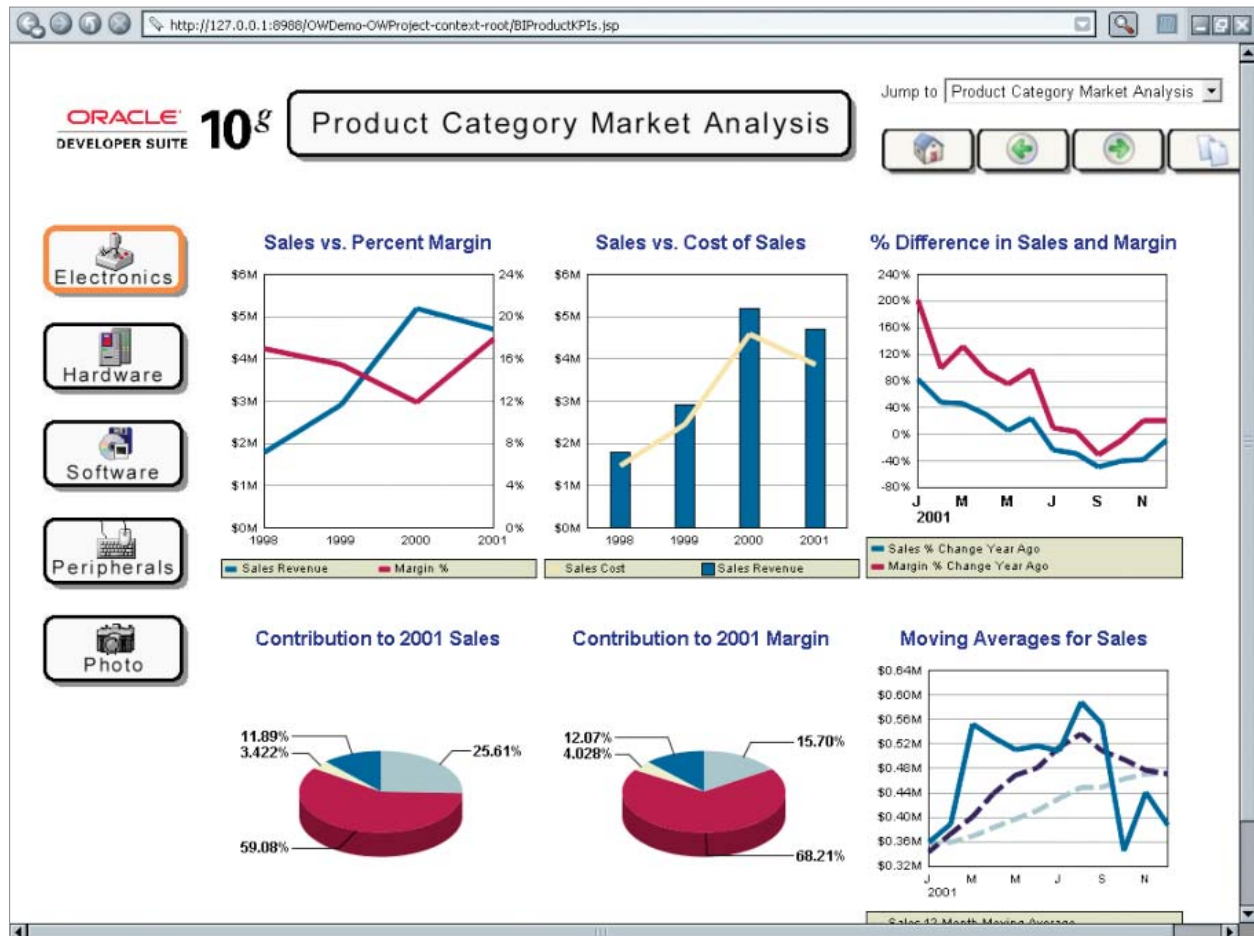
Figure 1-3

This dashboard from Informatica Corporation displays measures of revenue by sales channel along with a list of reports that can be viewed separately. The predominance of graphical display media that we observed on the previous dashboards appears on this one as well, notably in the form of meters designed to look like speedometers. The list of reports adds portal functionality, enabling this dashboard to operate as a launch pad to complementary information.
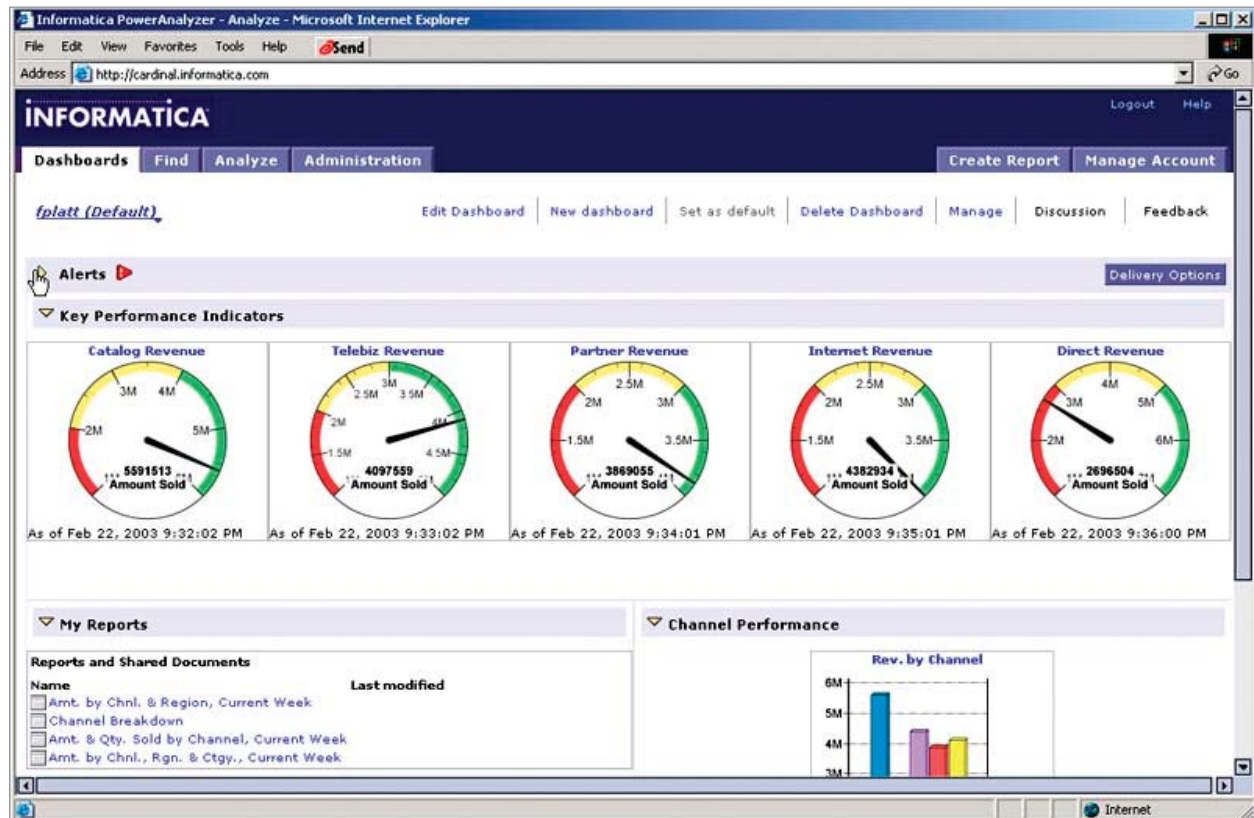
Figure 1-4

This dashboard from Principa provides an overview of a company's financial performance compared to targets for the month of March, both in tabular form and as a series of gauges. The information can be tailored by selecting different months and amounts of history. Once again, we see a strong expression of the dashboard metaphor, this time in the form of graphical devices that were designed to look like fuel gauges.
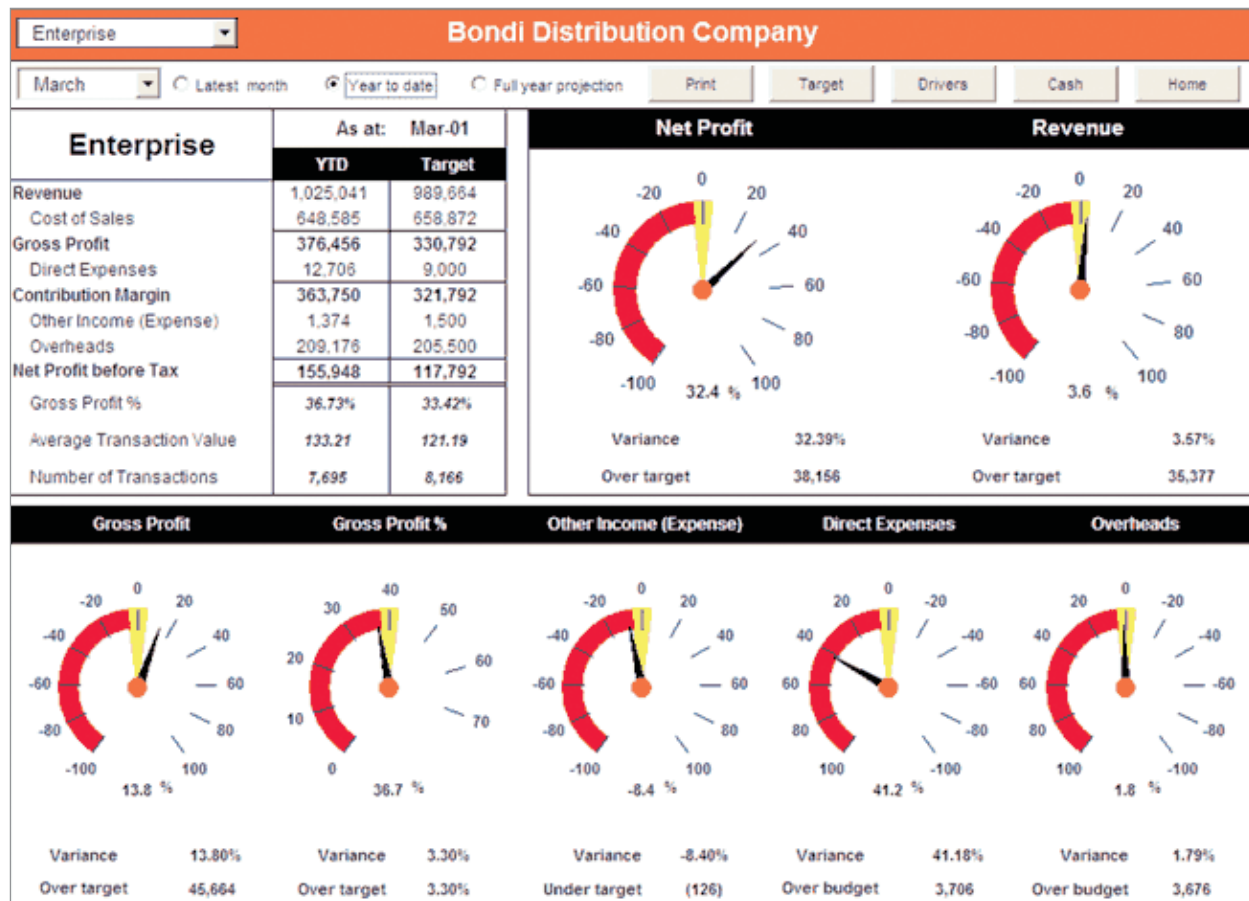
Figure 1-5

This dashboard from Cognos, Inc. displays a table and five graphs—one in the form of a world map—to communicate sales information. Despite the one table, there's a continued emphasis on graphical media. Notice also that a theme regarding the visual nature and need for visual appeal of dashboards is emerging in these examples.

Figure 1-6

This dashboard from Hyperion Solutions Corporation displays regional sales revenue in three forms: on a map, in a bar graph, and in a table. Data can be filtered by means of three sets of radio buttons on the left. These filtering mechanisms build rudimentary analytical functionality into this dashboard. Visual decoration reinforces the theme that dashboards intentionally strive for visual appeal.
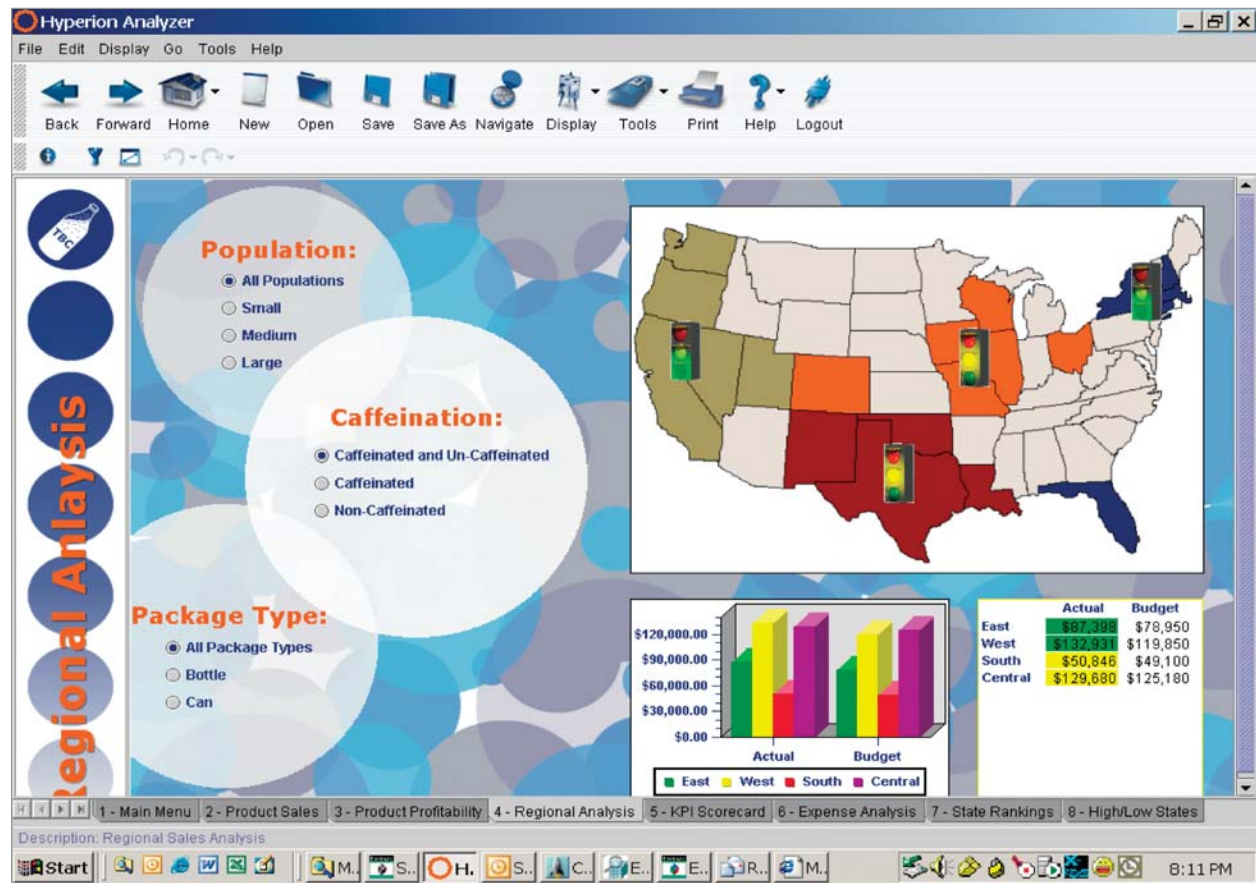
Figure 1-7

This dashboard from Corda Technologies, Inc. features flight-loading measures for an airline using four panels of graphs. Here again we see an attention to the visual appeal of the display. Notice also in the instructions at the top that an ability to interact with the graphs has been built into the dashboard, so that users can access additional information in pop-ups and drill into greater levels of detail.
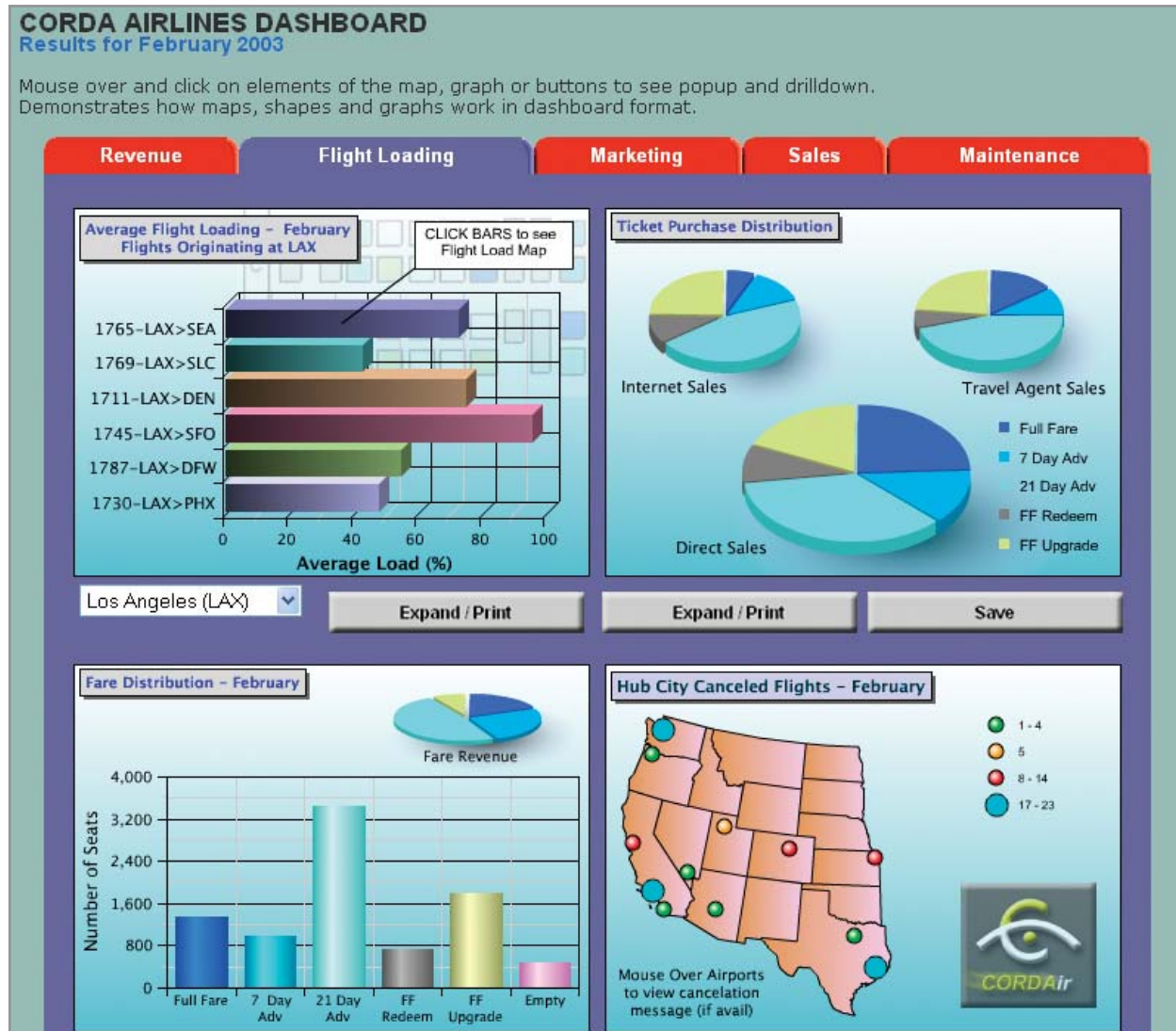
Figure 1-8

This dashboard from Visual Mining, Inc. displays various measures of a city's transit system to give the executives in charge a quick overview of the system's current and historical performance. Use of the colors green, yellow, and red to indicate good, satisfactory, and bad performance, as you can see on the three graphical displays arranged horizontally across the middle, is common on dashboards.
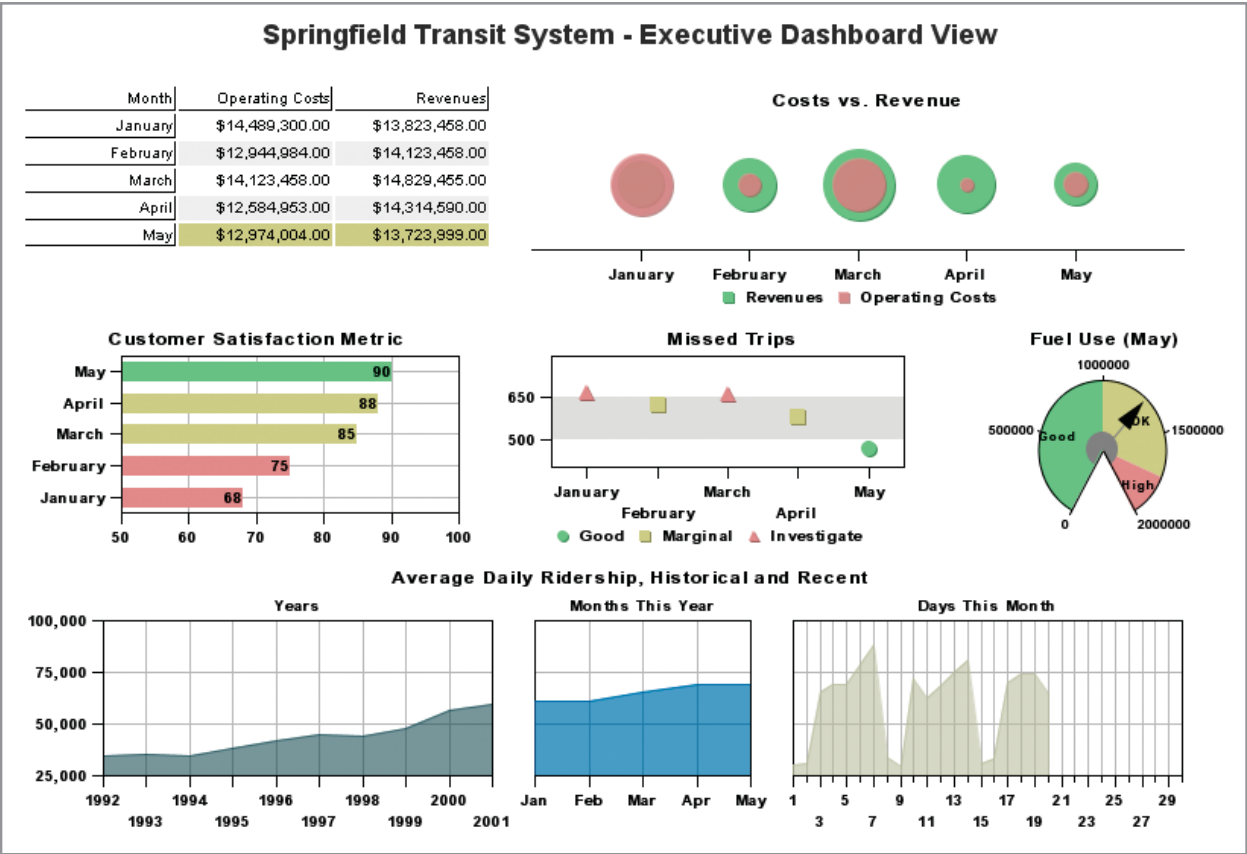
Figure 1-9

This dashboard from Infommersion, Inc. gives executives of a hotel chain the means to view multiple measures of performance, one hotel at a time. It is not unusual for dashboards to divide the full set of data into individual views, as this one does by using the listbox in the upper-left corner to enable viewers to select an individual hotel by location. The great care that we see in this example to realistically reproduce the dashboard metaphor, even down to the sheen on polished metal, is an effort that many vendors take quite seriously.

Figure 1-10

This dashboard from Celequest Corporation integrates a series of related tables and graphs that allow executives to view several aspects of sales simultaneously. It exhibits an effort to combine a rich set of related data on the screen to provide a comprehensive overview of a company's sales performance.
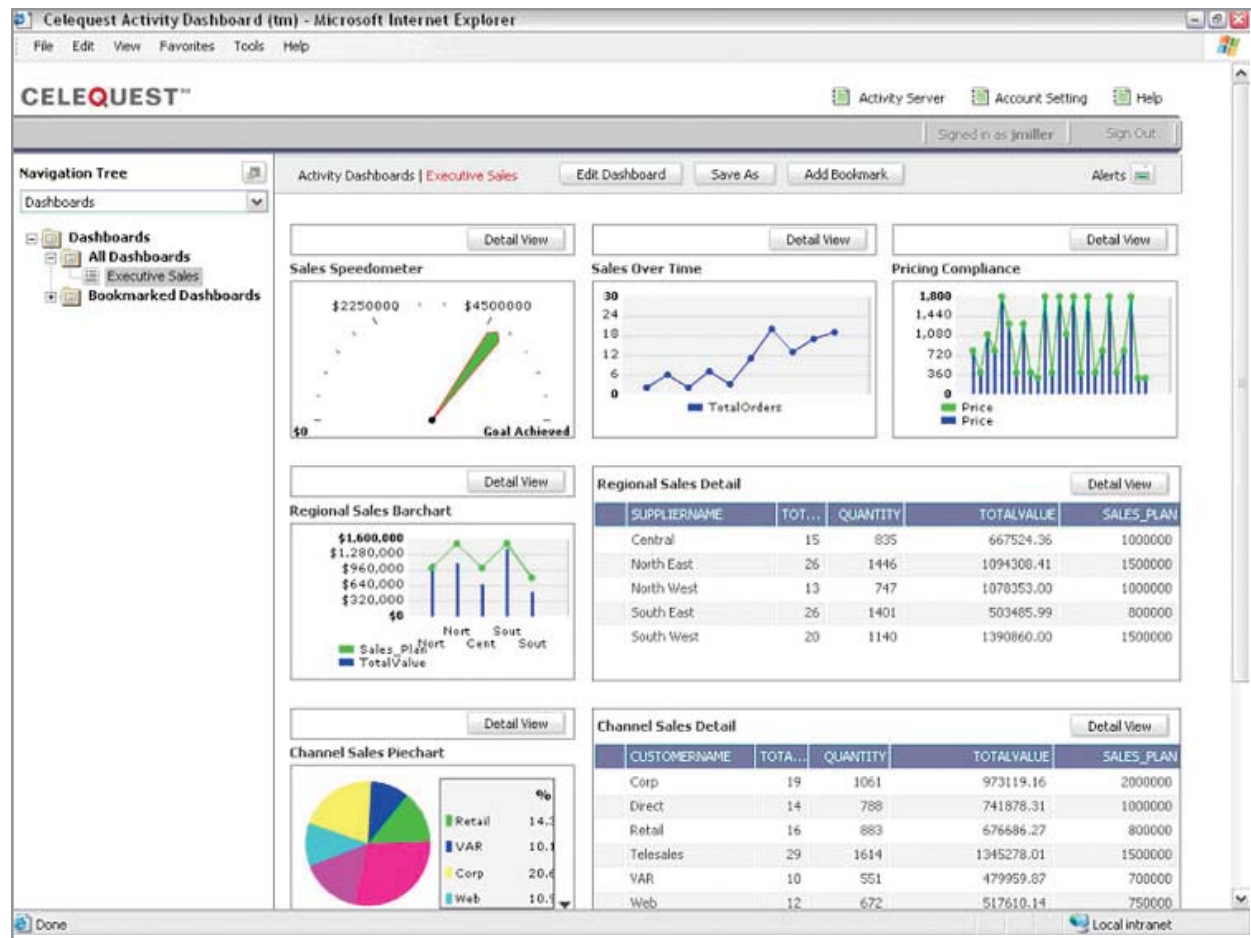
Figure 1-11

This dashboard from General Electric, called a "digital cockpit," provides a tabular summary of performance, complemented by a color-coded indicator light for each measure's status. Rather than a dashboard designed by a software vendor to exhibit its product, this is an actual working dashboard that was designed by a company to serve its own business needs. In this example, no effort was made to literally represent the dashboard (or cockpit) metaphor.

		Close Window
GE Business Digital Cockpit		□ ▣ ⊠
	GE Stock: **38.7** ▲+1.0 at 16:02 ET Jan 22, 2002	

Welcome, Jeffrey   ▣ **E-mail this Page** | 🖨 **Print this page**

Tools
📇 Message Center **(2)**
🗂 Cockpit Map
📑 Cockpit Pop-up
📲 Download to PDA
📊 View Charts

Total | Sub-business | Sub-business | Sub-business | Sub-business

Total Performance Summary   Last Update 1/21/02 7:59:16am

Sell

Metric	Alerts ▽		Result ▽	Alert Spec ▽	Last Update ▽
QTD Sales ($MM)	2	●	$ 153.0	$ 166.0	1/21/02
QTD Average Daily Order Rate (ADOR) ($MM)	1	○	$ 16.1	$ 11.9	1/21/02
Previous Day's Orders ($MM)	0	○	$ 26.2	$ 11.9	1/21/02
QTD % e-Orders	3	●	53.0%	59.0%	1/21/02
Current Qtr Price vs Target ($/lb)	6	○	$ 1.27	$ 1.20	1/21/02

Make

Metric	Alerts ▽		Result ▽	Alert Spec ▽	Last Update ▽
Span in Days	2	○	5	6	1/18/02
Finished Good Inventory	0	○	NA	NA	1/17/02
% Make To Inventory (MTI) of Total Inventory	0	○	NA	NA	1/17/02
QTD Digitization Savings ($MM)	7	●	$ 13.2	$ 20.3	1/21/02

Buy

Metric	Alerts ▽		Result ▽	Alert Spec ▽	Last Update ▽
YTD Indirect Conversion Cost % Change	1	●	-14%	-15%	1/17/02
YTD Indirect Short Term Cost % Change	2	○	-22%	-15%	1/17/02
Realized Direct e-Auction Savings YTD ($MM)	2	○	$ 5.4	$ 1.3	1/21/02
Closed Direct e-Auctions YTD ($MM)	4	○	$ 142.0	$ 55.0	1/21/02

Figure 1-12

This dashboard is used by the Treasury Board of Canada to monitor the performance of a project. Here again we have a dashboard that was designed by an organization for its own use. This time, the dashboard metaphor makes a token appearance in the form of gauges. The traffic-light colors green, yellow, and red—here with the addition of blue for the exceptionally good status of "ahead of schedule"—are also used. Unlike some of the examples that we've seen that displayed relatively little information, this one makes the attempt to provide the comprehensive overview that would be needed to effectively monitor progress and performance.
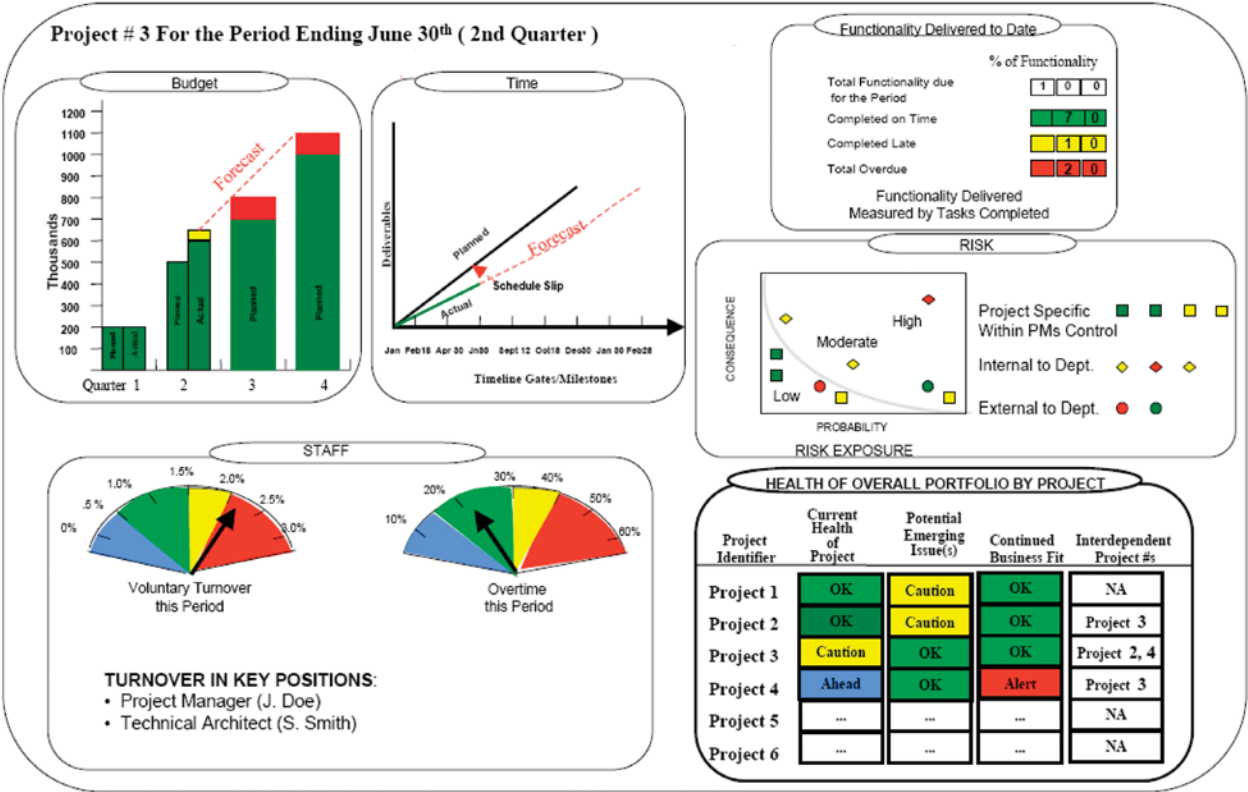
Figure 1-13

What Is a Dashboard?

As you have no doubt determined by examining these examples, there's a fair degree of diversity in the products that go by the name "dashboard." One of the few characteristics that most vendors seem to agree on is that for something to be called a dashboard it must include graphical display mechanisms such as traffic lights and a variety of gauges and meters, many similar to the fuel gauges and speedometers found in automobiles. This clearly associates BI dashboards with the familiar versions found in cars, thereby leveraging a useful metaphor—but the metaphor alone doesn't provide an adequate definition. About the only other thread that is common to these dashboard examples is that they usually attempt to provide an overview of something that's currently going on in the business.

After a great deal of research and thought, I composed a definition of my own that captures the essence of what I believe a dashboard is (clearly biased toward the characteristics of this medium that I find most useful and unique). To serve us well, this definition must clearly differentiate dashboards from other forms of data presentation, and it must emphasize those characteristics that effectively support the goal of communication. Here's my definition, which originally appeared in *Intelligent Enterprise* magazine:

Stephen Few, "Dashboard Confusion," *Intelligent Enterprise*, March 20, 2004.

> 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.

Just as the dashboard of a car provides critical information needed to operate the vehicle at a glance, a BI dashboard serves a similar purpose, whether you're using it to make strategic decisions for a huge corporation, run the daily operations of a team, or perform tasks that involve no one but yourself. The means is a single-screen display, and the purpose is to efficiently monitor the information needed to achieve one's objectives.

Visual display

of

**the most information needed to achieve one
or more objectives**

which

fits entirely on a single computer screen

so it can be

monitored at a glance

Let's go over the salient points:

Dashboards are visual displays. The information on a dashboard is presented visually, usually as a combination of text and graphics, but with an emphasis on graphics. Dashboards are highly graphical, not because it is cute, but because graphical presentation, handled expertly, can often communicate with greater efficiency and richer meaning than text alone. How can you best present the information so that human eyes can take it in quickly and human brains can easily extract the correct and most important meanings from it? To design dashboards effectively, you must understand something about visual perception—what works, what doesn't, and why.

Dashboards display the information needed to achieve specific objectives. To achieve even a single objective often requires access to a collection of information that is not otherwise related, often coming from diverse sources related to various business functions. It isn't a specific type of information, but information of whatever type that is needed to do a job. It isn't just information that is needed by executives or even by managers; it can be information that is needed by anyone who has objectives to meet. The required information can be and often is a set of KPIs, but not necessarily, for other types of information might also be needed to do one's job.

A dashboard fits on a single computer screen. The information must fit on a single screen, entirely available within the viewer's eye span so it can all be seen at once, at a glance. If you must scroll around to see all the information, it has transgressed the boundaries of a dashboard. If you must shift from screen to screen to see it all, you've made use of multiple dashboards. The object is to have the most important information readily and effortlessly available so you can quickly absorb what you need to know.

Must the information be displayed in a web browser? That might be the best medium for most dashboards today, but it isn't the only acceptable medium, and it might not be the best medium 10 years from now. Must the information be constantly refreshed in real time? Only if the objectives that it serves require real-time information. If you are monitoring air traffic using a dashboard, you must immediately be informed when

something is wrong. On the other hand, if you are making strategic decisions about how to boost sales, a snapshot of information as of last night, or perhaps even the end of last month, should work fine.

Dashboards are used to monitor information at a glance. Despite the fact that information about almost anything can be appropriately displayed in a dashboard, there is at least one characteristic that describes almost all the information found in dashboards: it is abbreviated in the form of summaries or exceptions. This is because you cannot monitor at a glance all the details needed to achieve your objectives. A dashboard must be able to quickly point out that something deserves your attention and might require action. It needn't provide all the details necessary to take action, but if it doesn't, it ought to make it as easy and seamless as possible to get to that information. Getting there might involve shifting to a different display beyond the dashboard, using navigational methods such as drilling down. The dashboard does its primary job if it tells you with no more than a glance that you should act. It serves you superbly if it directly opens the door to any additional information that you need to take that action.

That's the essence of the dashboard. Now let's add to this definition a couple more supporting attributes that help dashboards do their job effectively:

Dashboards have small, concise, clear, and intuitive display mechanisms. Display mechanisms that clearly state their message without taking up much space are required, so that the entire collection of information will fit into the limited real estate of a single screen. If something that looks like a fuel gauge, traffic signal, or thermometer fits this requirement best for a particular piece of information, that's what you should use, but if something else works better, you should use that instead. Insisting on sexy displays similar to those found in a car when other mechanisms would work better is counterproductive.

Dashboards are customized. The information on a dashboard must be tailored specifically to the requirements of a given person, group, or function; otherwise, it won't serve its purpose.

A dashboard is a type of display, a form of presentation, not a specific type of information or technology. Keep this distinction clear, and you will be freed to focus on what really matters: designing dashboards to communicate.

A Timely Opportunity

Several circumstances have recently combined to create a timely opportunity for dashboards to add value to the workplace, including technologies such as high-resolution graphics, emphasis on performance management and metrics, and a growing recognition of visual perception as a powerful channel for information acquisition and comprehension. Dashboards offer a unique solution to the problem of information overload—not a complete solution by any means, but one that helps a lot. As Dr. Hovis wrote in that same article in *DM Direct*:

> The real value of dashboard products lies in their ability to replace hunt-and-peck data-gathering techniques with a tireless, adaptable, information-flow mechanism. Dashboards transform data repositories into consumable information.

Gregory L. Hovis, "Stop Searching for Information – Monitor it with Dashboard Technology," DM Direct, February 2002

Dashboards aren't all that different from some of the other means of presenting information, but when properly designed the single-screen display of integrated and finely tuned data can deliver insight in an especially powerful way.

> Dashboards and visualization are cognitive tools that improve your "span of control" over a lot of business data. These tools help people visually identify trends, patterns and anomalies, reason about what they see and help guide them toward effective decisions. As such, these tools need to leverage people's visual capabilities. With the prevalence of scorecards, dashboards and other visualization tools now widely available for business users to review their data, the issue of visual information design is more important than ever.

Richard Brath and Michael Peters, "Dashboard Design: Why Design is Important," *DM Direct*, October 2004

The final sentiment that Brath and Peters expressed in this excerpt from their article underscores the purpose of this book. As data visualization becomes increasingly common as a means of business communication, it is imperative that expertise in data visualization be acquired. This expertise must be grounded in an understanding of visual perception, and of how this understanding can be effectively applied to the visual display of data—what works, what doesn't, and why. These skills are rarely found in the business world, not because they are difficult to learn, but because the need to learn them is seldom recognized. This is true in general, and especially with regard to dashboards. The challenge of presenting a large assortment of data on a single screen in a way that produces immediate insight is by no means trivial. Buckle up; you're in for a fun ride.