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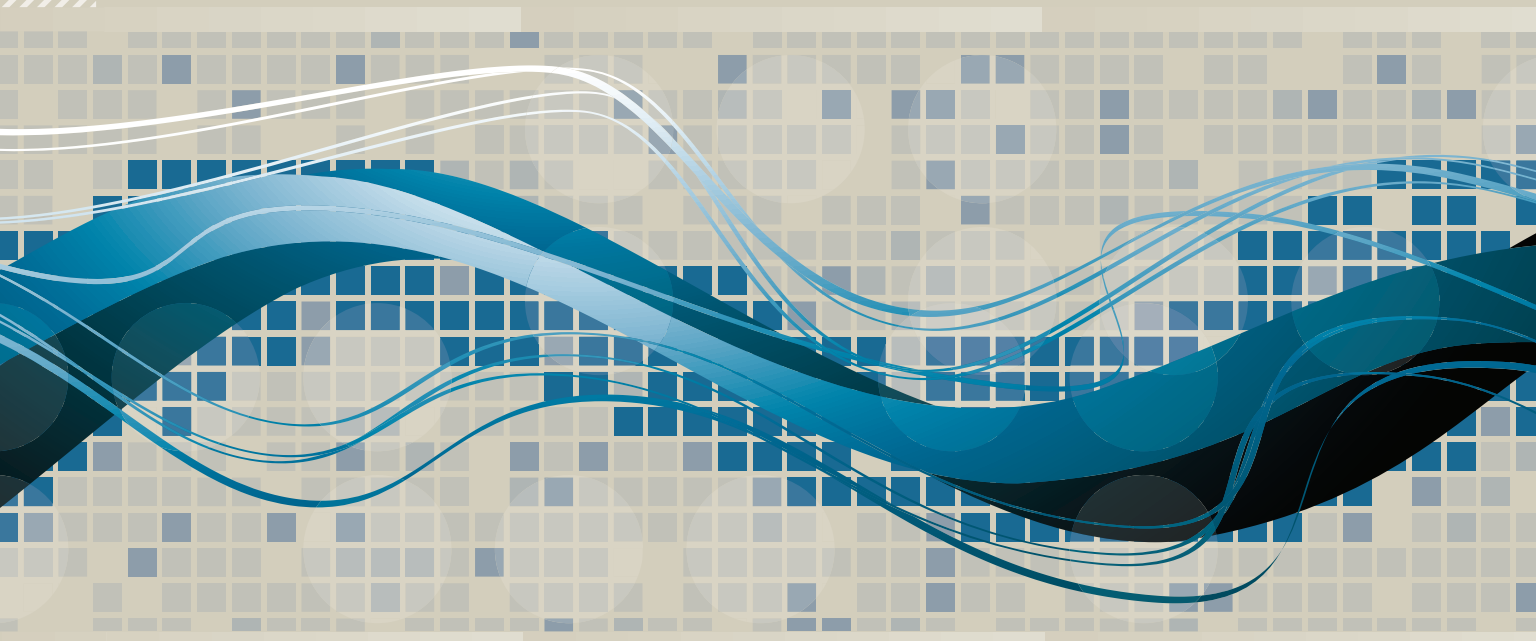
TDWI BEST PRACTICES REPORT

FIRST QUARTER 2011

VISUAL REPORTING AND ANALYSIS

Seeing Is Knowing

By Wayne Eckerson and Mark Hammond



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About TDWI

TDWI, a division of 1105 Media, Inc., is the premier provider of in-depth, high-quality education and research in the business intelligence and data warehousing industry. TDWI offers a worldwide Membership program, five major educational conferences, topical educational seminars, role-based training, onsite courses, certification, solution provider partnerships, an awards program for best practices, live Webinars, resourceful publications, an in-depth research program, and a comprehensive Web site: tdwi.org.

About the TDWI Best Practices Reports Series

This series is designed to educate technical and business professionals about new business intelligence technologies, concepts, or approaches that address a significant problem or issue. Research for the reports is conducted via interviews with industry experts and leading-edge user companies and is supplemented by surveys of business intelligence professionals.

To support the program, TDWI seeks vendors that collectively wish to evangelize a new approach to solving business intelligence problems or an emerging technology discipline. By banding together, sponsors can validate a new market niche and educate organizations about alternative solutions to critical business intelligence issues. Please contact TDWI Research Senior Manager Philip Russom (prussom@tdwi.org) to suggest a topic that meets these requirements.

Acknowledgments

TDWI would like to thank many people who contributed to this report. First, we appreciate the many users who responded to our survey, as well as those who responded to our requests for phone interviews. We would also like to recognize TDWI's account and production team: Jennifer Agee, Michael Boyda, and Denelle Hanlon.

Sponsors

ADVIZOR Solutions, Corda, DSPanel, Dundas, IBM, Microsoft, MicroStrategy, Oracle, SAS, and Tableau Software sponsored the research for this report.

Executive Summary

Data visualization is increasingly an essential element of business intelligence (BI). No longer restricted to specialized applications, data visualization in the form of charts, maps, and other graphical representations is enabling business users to better understand data and use it to achieve tactical and strategic objectives. Moreover, data visualization is prompting a cultural shift toward more analytic, data-driven business and operations by empowering users to explore, in a graphically inviting medium, data that was previously available only in tabular reports.

This TDWI Best Practices Report, which is based on a Web survey of BI professionals and interviews with BI practitioners and experts, finds that data visualization is in the middle of a remarkable growth phase. It also reveals that data visualization contributes impressively to improvements in business user insight and productivity, as well as usage of dashboards (the preferred medium for data visualization). For instance, 74% of our survey respondents credit data visualization for a “very high” or “high” increase in business user insights.

But data visualization is never a plug-and-play solution, and one size does not fit all. Dashboard design and usage can and should vary by types of users (for example, executives versus front-line staff), purpose (strategic, tactical, operational), and industry and organizational culture (a healthcare organization versus a clothing manufacturer). Customization, collaboration, and iteration are required for organizations to operate interactive visual reporting and analysis solutions that deliver maximum benefits.

Research Methodology

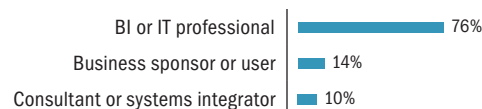
Focus. This report is designed for BI professionals and business users who develop and use business dashboards and other means of visual reporting and analysis.

Methodology. This research for this report includes a Web survey of BI professionals and business users that TDWI conducted in the summer of 2010, as well as in-depth interviews with BI practitioners and data visualization solutions providers. The survey drew responses from 222 respondents. From these, we excluded incomplete responses and respondents who identified themselves as academics or vendor employees. The completed surveys of 210 respondents form the core data sample for this report.

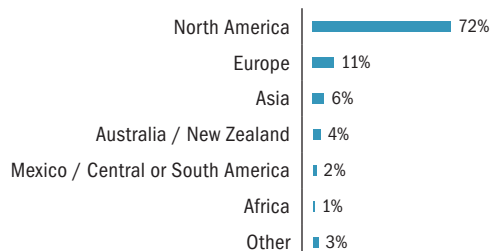
Throughout the report, rounding and multi-choice questions account for percentages that do not total 100%.

Survey Respondent Profile. More than three-quarters (76%) of respondents are BI or IT professionals. More than 70% are based in the United States. Financial services, software/Internet, and healthcare are the most represented of more than two dozen industries. The following charts highlight key characteristics of the respondent pool.

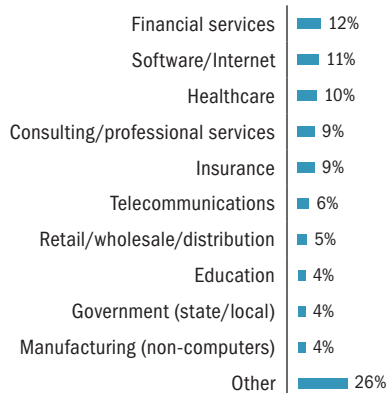
What is your position?



Where are you located?



Which is your company's industry?



The Evolution of Data Visualization

Long before there were servers and laptops, dashboards and drilldowns, OLAP and AJAX, heatmaps or histograms, there was data visualization.

The world's first bar, line, and pie charts of any renown are believed to have been devised in the late 1700s by a Scottish engineer and political economist, William Playfair (1759–1823). Considered the founder of graphical data representation, Playfair produced a number of visualizations on economic and political issues of interest to the British empire. For instance, Playfair visually portrayed the growth of British debt from 1688 to 1800 in a graphic called “Chart of the National Debt of England” (Figure 1).

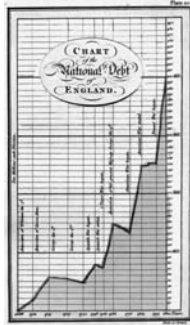


Figure 1. Chart of the National Debt of England

Of course, Playfair labored with a crude pen and ink to produce his illustrations. He had no photocopier, scanner, or Web site to showcase and propagate his work—only a small number of books. Given the toil involved and the absence of a mass audience display media, it's perhaps unsurprising that Playfair's innovation had little impact, and that data visualization would not become widespread until the advent of computing.

An observation Playfair made in the 18th century is true in the 20th century as well: “On inspecting any one of these Charts attentively, a sufficiently distinct impression will be made ... and the idea which does remain will be simple and complete.”¹

Graphical versus tabular representation

Mass Market. Although this report focuses on data visualization in corporate environments, it is worth noting that data visualization is on the rise in the public realm as well. For instance, *The Wall Street Journal* offers at its Web site a free section called Interactive Graphics, featuring many dozens of charts, maps, and other graphics. Users can select their own dimensions to build custom charts, manipulate maps, use sliders, generate mouse-over text, and more. *The New York Times* offers a similar section called Visualization Lab on its Web site.

Amateur investors have at their disposal a rich array of interactive charts from financial information providers and brokerage firms to analyze both individual stock performance and market trends. TD Ameritrade, for instance, offers a free visual application called Pattern Matcher that lets users pattern-match securities against certain technical market-level indicators. In effect, visualization is helping to influence stock purchases by Main Street investors.

Data visualization for consumers

Data visualization has even found its way into consumer communication and recreation. For example, a free tool called Graph Your Inbox, released in September 2010, enables Gmail users to graphically view e-mail activity and trends. At about the same time, Yahoo! introduced a feature

that let fantasy baseball managers view as line charts changes in standings over the season or select time periods by a number of dimensions (home runs, strikeouts, and so on). Naturally, as we become increasingly accustomed to interacting with visually presented data in our consumer lives, we come to expect the same in our business environments.

Data Visualization for Business

Graphical representations of data communicate patterns, trends, and outliers far more quickly than tables of numbers and text. With visualization, users can spot issues and problems needing attention at a glance and take appropriate action. In text-based reports and spreadsheets, the trends and issues remain hidden among dizzying arrays of numbers and text. Because of its power to communicate, data visualization is becoming more pervasive in business environments.

For instance, Airlines Reporting Corporation (ARC), a Virginia-based provider of data and transaction solutions for the travel industry, is replacing its fairly static, text-based reports with dashboards and other visual solutions to make data more accessible and easier to use for customers.

“With the graphics, it’s much easier for the eye and the brain to understand what’s happening in the data,” says Sheila Cuyjet, ARC’s director of analytic services. “It helps people see what is going to happen rather than what has already happened, and I think that’s a natural progression of analytics.”

One of the largest banks in the U.S. recently rolled out a visual dashboard to about 1,000 managers to help them monitor and manage productivity throughout the company’s regions and divisions. The MicroStrategy-based dashboard summarized information from 25 previous Excel-based reports, each with multiple pages and tabs. “Who has time to go through all that?” says the bank’s vice president of BI. “Now it’s all right in front of them.”

Data visualization is becoming more pervasive.

Data Visualization Inhibitors

Text Still Prevails. Despite the growing popularity of data visualization, users still spend almost two-thirds (65%) of their time analyzing data in tables and text, according to our survey. (See Figure 2.) But only 12% of respondents ranked tables as “highly” useful in helping users glean insights and make decisions (see page 18).

What percentage of the time do BI users view data graphically versus textually?

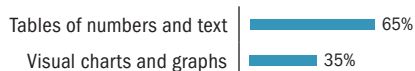


Figure 2. Based on 210 respondents.

A number of sponsors of this report observed the gradual uptake of visualization. “There are still a lot of companies that don’t have visualization solutions in place, or if they do, it’s only for a small number of people,” said Niklas Derouche, CTO of BI and visualization vendor DSPanel. “But demand for visualization is growing, with the big change being a move from static to interactive to collaborative business intelligence.”

Old Habits Die Hard. Although some data is better suited to non-visual rendering, it’s clear that old habits die hard. Many executives and managers, for example, have run operations for years using text-based budgets and plans created in Excel. Likewise, business analysts, who are generally Excel jockeys, are often more comfortable with grids of data because that is how they’ve always interfaced with information.

As a result, it's sometimes difficult to introduce visual alternatives. For example, Bruce Yen, director of business intelligence at the GUESS clothing company, encountered resistance when he replaced text- and numeral-based reports with charts. "We showed bar charts on how sales broke down by department, but some users said they could simply look at the numbers and get the same answer. Maybe the data and analysis wasn't so complex that it needed a bar chart or some other type of visualization," said Yen.

Poor visual design makes users work harder to get desired information.

Poor Visual Design. Another problem is that many visual displays are so poorly designed that they actually force users to work harder to get information they need. For example, users will reject a new visual interface if it forces them to click one or more times to view related information that they think should be on a single page. Users will become frustrated if the visual design is so decorative that it is distracting or obscures the meaning of the data. Well-designed visualizations should convey much more information at a glance than users can absorb by looking at numbers.

Visual Overload. In addition, some designers may pack too much information and functionality into a visual reporting or analysis tool and overwhelm new users. The best visual displays introduce new functionality and information gradually over time. As users become more familiar with the new environment, they typically want to view more data on a single screen and request more functions to manipulate the data. Visualization tools that expose data and functionality on demand will have higher rates of adoption among users.

Veteran BI vendors have learned this lesson. For example, IBM delivered new "on demand" features in its new IBM Cognos 10 BI tool that expose additional report design features when users click on a button labeled "Do more."

Sometimes text is the appropriate visual option.

The Role of Text. Of course, there are times when text is the appropriate way to communicate data, such as listing the top 10 customers, bottom 10 products, projects at risk, or highest-performing salespeople. It is also appropriate when users need to know the exact value or amount of a metric. Graphical views that summarize performance in a dashboard often give way to more table-driven views at lower levels of detail. That's the case at Wyndham Exchange and Rentals (WER), a New Jersey-based vacation rental and exchange network that provides a dashboard to about 30 account managers in its inventory management team.

"Users can see something in a higher-level report, and drill down with the OLAP tool to see exactly what's driving a decline in a certain area," said Jeremy TerBush, WER VP of Global Analytics. "It doesn't take them too long before they just want to see a table with data."

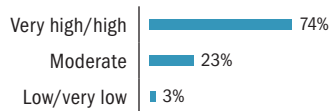
Benefits of Data Visualization

Given the prevalence of text-based graphics, it's clear that data visualization is in the early stages of industry adoption, but its popularity is growing quickly. That's largely because it's so easy to see (literally) and experience the benefits of data visualization.

TDWI research shows that data visualization significantly improves business insights and user productivity (that is, accelerates time to insight) and increases user adoption of BI tools. These benefits help explain the growing popularity of data visualization in corporate environments.

Business Insights. For example, nearly three-quarters (74%) of respondents to our survey rated the influence of data visualization on business insights as "very high" or "high"; 23% characterized the improvements as "moderate." (See Figure 3.)

To what degree did data visualization improve business insight?



Visualization improves business insights.

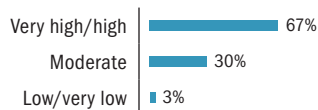
Figure 3. Based on 210 respondents.

“The combination of data discovery and visualization enables users to uncover hidden relationships they didn’t know existed,” said Judy Doherty, director of Information Management Systems at Dartmouth College in New Hampshire, which uses dashboards created with ADVIZOR Solutions to support fund-raising and alumni relations. “I’ll often hear, ‘Why didn’t we have this data before?’” Doherty said. “In fact, they did have it, in a report—they just didn’t see it.”

SWBC, a San Antonio, Texas–based financial services provider, recently replaced paper-based reports for 70 managers with a dashboard that gives account managers visibility into the profitability of their accounts, said Tommy Meuth, VP of business intelligence at SWBC. “The dashboard provides managers with instant insights about how they can decrease their loss-ratio exposure, and that will increase our profitability.”

Productivity. Besides improving insights, data visualization accelerates user productivity. More than two-thirds (67%) of our respondents felt that data visualization had a “very high” or “high” influence on user productivity, which our survey also called “time to insight.” (See Figure 4.)

To what degree did data visualization improve user productivity?



Visualization makes users more productive.

Figure 4. Based on 210 respondents.

With visualization, users can identify relevant patterns and trends that might take hours or days with tabular reports. As a result, analysts can spend more time analyzing data and less time finding or creating it. “Business users no longer have to spend time building pivot tables or running SQL queries,” said Doherty of Dartmouth.

At UPS, a dashboard that replaced a cumbersome set of spreadsheets tracks the cargo and carrying capacity of UPS trucks in transit and saved the company \$2.5 million in 2009. “The need for speed really drove this, and that’s when we began to move towards data visualization,” said Martin Click, executive director of UPS Global Network Development and Support. “We had so much data, we weren’t sure what to do with it.”

Adoption. Because it accelerates time to insight, data visualization improves the rate of user adoption of new visual applications. According to our survey, more than three-quarters of respondents (79%) said data visualization increased user adoption to a “very high” or “high” degree. Only 2% rated the impact on dashboard adoption as neutral or low. (See Figure 5.)

Visualization increases user adoption of dashboards.

To what degree did data visualization increase dashboard adoption?

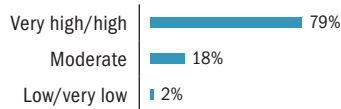


Figure 5. Based on 210 respondents.

For example, Advance Auto Parts recently created a performance dashboard that visually displays store sales against targets. As measured by unique daily log-ins, the adoption rate for the dashboard, which was rolled out to thousands of employees, has been substantially higher than other information systems at the company. Moreover, the dashboard was voted the number one store system in a user survey. The use of visualization was a key factor in its adoption, according to Bill Robinette, director of Business Intelligence Systems at Advance Auto Parts.

Cultural Impact. Visualization is helping to instill a more analytic culture at Kaleida Health, the largest healthcare provider in western New York, which has deployed about 50 dashboards to more than 300 employees in finance, operations, and quality monitoring and analysis. Kaleida’s Oracle-based dashboards have created a new paradigm in which users rely on data to drive decisions. “[The dashboards] are changing a lot of behavior in how people manage. They’re helping people do their jobs better, both on a daily basis and from a strategic perspective,” says Daniel Gerena, Kaleida’s director of BI and analytics.

Strong visualization makes it easier to sell BI solutions.

Impact on Purchases. Not surprisingly, visualization has a major impact on sales of BI solutions. More than 70% of respondents said visualization had a “high” or “very high” impact on their past dashboard purchases. An even higher percentage (79%) said data visualization would influence future purchases to a “high” or “very high” degree. (See Figure 6.) This indicates that once data visualization gains a beachhead in an organization and BI managers see the impact it has on user insights and productivity, its influence spreads wide and far.

Rate the influence of visualization capabilities on past and future dashboard purchases.

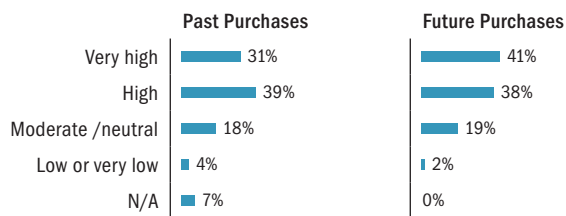


Figure 6. Based on 210 respondents.

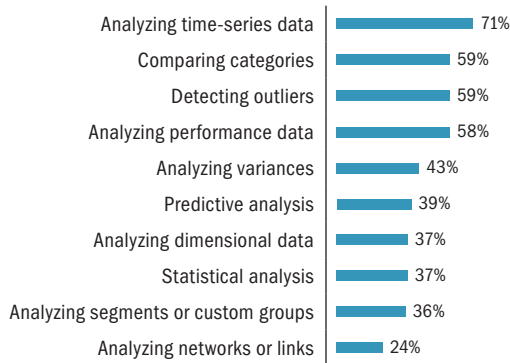
The visual appeal of an attractive dashboard can make it an easy sell during a business-case presentation, especially if it illustrates dollars and cents in a visually compelling manner, as was the case at UPS. “We showed upper management a visual map of how and where they were losing money” and it made an immediate impact, said Chris Cushman, UPS Enterprise Network Planning supervisor.

Elissa Fink is VP of marketing at Tableau Software (a small but fast-growing company that has been pitching visual analysis tools for several years). She says, “Companies don’t always recognize the benefits of data visualization until they begin using it, and then it’s ‘Wow!’” During prototype

sessions, business users begin seeing problems and taking action. That’s when you know data visualization will impact purchase decisions.

Analytical Tasks. Visualization plays an important role in helping users perform various analytical tasks. Chief among these is using visualization to analyze time-series data, given a “high” rating by 71% of respondents. This is no surprise, since a primary way that businesses track their progress is to compare current performance to prior periods, generally in the form of a line chart. (See Figure 7.)

Rate the degree of usefulness of visualization for the following analytical tasks.



Data visualization is ranked as most important in time-series analysis.

Figure 7. Based on 210 respondents who ranked visualization’s importance as “high.”

Other analytical tasks in which visualization plays a highly useful role include comparing categories (59%), detecting outliers (59%), and analyzing performance data (58%). Together, these analytical tasks may be considered the “four horsemen” of visual reporting and analysis.

Visualization is also important, but to a lesser degree, when analyzing variances (43%), doing predictive analysis (39%), analyzing dimensional data (37%), performing statistical analysis (37%), analyzing segments or custom groups (36%), and analyzing networks or links (24%). Given these results, it’s clear that visualization plays a significant role in every type of analysis highlighted by our survey.

Departmental Usage. Interestingly, data visualization has made its greatest inroads in the executive suite. Almost three-quarters of our respondents (74%) rate the importance of visualization to executives as “high.” This is 14 percentage points higher than the next department on the list. (See Figure 8.)

Executives and managers are usually the primary users of dashboards.

Rate the degree of importance of data visualization to the following departments.

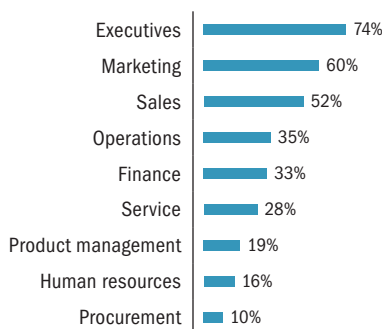


Figure 8. Based on 210 respondents who ranked visualization’s importance as “high.”

Typically, executives want a quick, bird’s-eye view of how the business is performing along key metrics, and a visual dashboard is the perfect medium to satisfy those needs. Executives who transition from spreadsheets and reports to a visual dashboard feel as if “they’d been driving a Dodge Neon and you just put them in a Lamborghini,” said Meuth of SWBC.

The marketing (60%) and sales (52%) departments also rate data visualization highly. These departments manage the lifeblood of any company—its revenues—and therefore must track many interactions and transactions on a daily basis. Data visualization helps bring clarity to the mass of information and enables users to quickly spot problems and take action.

Trailing the departmental pack in their view of the importance of data visualization are operations (35%), finance (33%), service (28%), product management (19%), human resources (16%), and procurement (10%).

Data Visualization Technology

Two Categories. There are two main categories of data visualization technology: visual reporting and visual analysis.

- **Visual reporting.** Visual reporting uses charts and graphics to depict business performance, usually defined by metrics and time-series information. The primary type of visual report is a dashboard or scorecard, which gives users a visual snapshot of performance. The best dashboards and scorecards enable users to drill down one or more levels to view more detailed information about a metric. In essence, a dashboard is a visual exception report, highlighting performance anomalies using visualization techniques.
- **Visual analysis.** Visual analysis, on the other hand, enables users to visually explore data to discover new insights. While visual reporting structures the navigation of data around predefined metrics, visual analysis provides a much higher degree of data interactivity. With visual analysis, users can visually filter, compare, and correlate data at the speed of thought. Visual analysis tools also often incorporate forecasting, modeling, and statistical, what-if, and predictive analytics.

Visual Reporting

Dashboards. By a sizable margin, dashboards are the preferred medium for data visualization. Nearly 85% of respondents ranked the importance of visualization as “high” in dashboards. On the other end, only 33% considered visualization to be highly important in an OLAP tool. (See Figure 9.)

Rate the importance of visualization in the following categories of BI tools.

Dashboards are a popular medium for visualization.

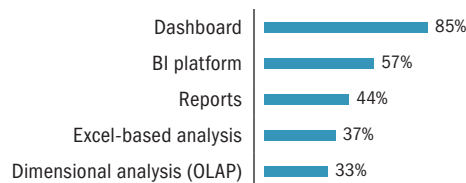


Figure 9. Based on 210 respondents who ranked visualization’s importance as “high.”

There are a near-infinite number of ways to design the visual elements of a performance dashboard. Most dashboards arrange a series of related charts in a grid template, usually two-over-two or three-over-three, and use multiple tabs or radio buttons to segment charts by category. They also usually display filters above or beside the charts they apply to, as well as links to related dashboards or reports. The best dashboards display summary data graphically so it can be consumed at a glance and then provide access to any detailed information a user might need within three clicks.

The best dashboards provide access to any information within three clicks.

Sample Dashboard. For example, the dashboard from Rohm & Haas (now owned by Dow Chemical) is embedded in the company's corporate portal, which has links (arrayed on top) to other enterprise content as well as other dashboards housed by the portal. (See Figure 10.) The dashboard itself consists of a table of 10 key performance indicators (established by top executives) that apply to every business unit and region in the company, along with pertinent targets (last year, variance, percentage change, and so on). Next to each metric are visual stoplights, which indicate the status of performance for the given metric against a selected target. Stoplights are perhaps the most common way to visually highlight exception conditions in a dashboard because they attract a user's attention quickly.

Below the grid are two somewhat interactive charts that show a time-series trendline for the metric highlighted by the user's cursor above. The left-hand panel contains the navigation path to the current view, and below that, a set of filters that users can use to change the alert in the grid and drill down to view performance along the same metrics at lower levels of the organization. (These filters are "universal" in that they apply to all objects on the screen instead of a single object.) The bottom of the panel contains hard-coded links to related dashboards and reports.

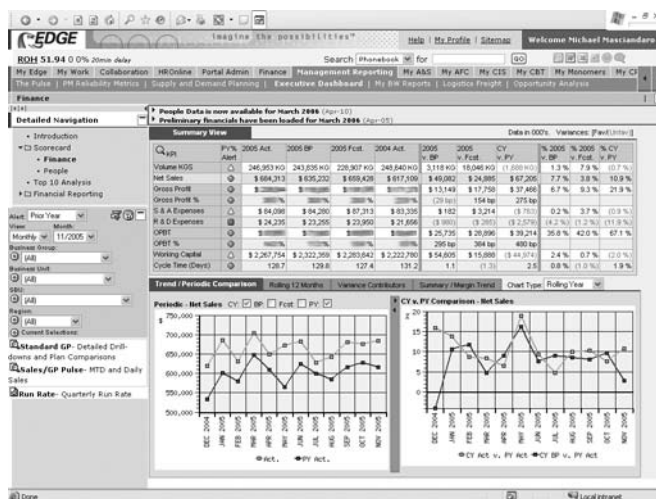


Figure 10. Rohm and Haas enterprise dashboard

As you can see, the Rohm & Haas enterprise dashboard gives executives and managers a snapshot of performance for their domains with alerts to highlight exceptions and moderate levels of interactivity to drill into details and view related information. With a glance, executives and managers can see the status and trend of performance in their areas and how it compares to major benchmarks. Many companies are adopting this type of visualization to better monitor and manage performance.

Visual Analysis

Speed-of-thought visual exploration

Visual analysis tools enable power users and business analysts (such as financial, marketing, and sales analysts) to explore data sets visually and identify trends and anomalies. These tools usually work with data stored in memory and expose rich navigational features that let users explore data at the speed of thought. Many also incorporate some form of statistical or predictive analytics.

Visual analysis tools compress and store data in memory, providing sub-second response times for any action taken against the data (such as filtering, drilling, calculating, sorting, and ranking). Visually, analysts point and click to interact with charts, apply filters, and change views. For instance, analysts can use their mouse to “lasso” data points in a certain section of a scatter plot to create a new group and automatically filter other charts on the page. (See Figure 11.)

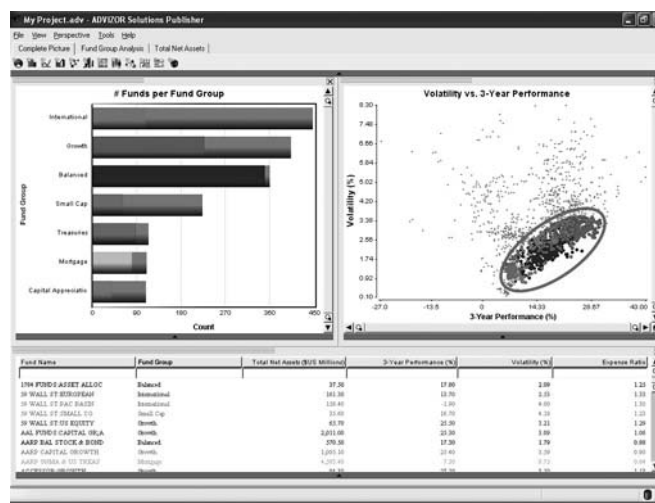


Figure 11. Pointing and clicking can generate custom groupings.

Compared to OLAP tools, visual analysis tools don't require an IT person to design a dimensional data model. The tools use a “load-and-go” approach in which analysts load raw data from multiple sources and simply link tables along common keys to get a unified view of the data set. As a result, most visual analysis tools can be deployed in a few hours or a few days or weeks, depending on the number of data sources and their complexity and cleanliness.

Visual analysis tools enable power users to publish views to others.

Analysts or developers often use visual discovery tools to create and publish interactive, departmental dashboards for casual users. They often create the dashboards on desktop machines and then publish them to a departmental server for general consumption. When doing so, the developers generally strip out some analytical functionality and options that might overwhelm casual users.

Two Environments. It should be clear that visual reporting and visual analysis tools serve two different audiences and purposes. While visual reporting tools are designed to visualize performance against predefined metrics for executives and managers, visual analysis tools empower business analysts to explore trends and anomalies in data sets they create and publish views for others to consume.

Visualization Technology

Both types of visualization solutions leverage emerging technology to enhance the visual experience of BI users. Here are key technologies driving the adoption of visualization in corporate environments.

- **64-bit systems and multi-core servers.** Charting engines chew up a lot of CPU cycles, especially if the charts are interactive. Rendering charts, especially in server-based environments, takes a lot of horsepower. Today's 64-bit platforms and multi-core processors speed visual processing to give users more dynamic and interactive visual environments in which to view data.
- **RAM and compression.** Many visualization tools work with in-memory data to ensure speed-of-thought interactivity. With prices for RAM dropping, it's easier for power users to analyze large data sets (up to 50 million records) held in memory. New compression techniques increase the amount of data that can be held in memory—but be cautious of decompression performance penalties.
- **Java applets/Active X controls.** These mini-applications run inside a Web browser and execute within a virtual machine or sandbox. Actions execute as fast as compiled code, making them an easy way to recreate full-featured applications on the Web. However, they raise security concerns, so many IT administrators prevent users from downloading such controls through corporate firewalls, which limits their pervasiveness.
- **DHTML and AJAX.** A lighter-weight approach is to embed a scripting language inside HTML pages, such as JavaScript, that execute functions in the browser. Dynamic HTML (DHTML) uses scripting to animate a downloaded HTML page. For example, DHTML is often used to animate drop-down boxes, radio buttons, mouseovers, and tickers, as well as capture user inputs via forms. AJAX (asynchronous JavaScript and XML) takes this one step further and retrieves new content from the server in the background without interfering with the display and behavior of the page. Basically, AJAX enables users to add new data to the dashboard without having to reload the entire page. It can also be used to pre-fetch data, such as the next page of results.
- **Flash.** Another popular approach is to use multimedia development platforms, such as Adobe Flash, Java applets, Microsoft Silverlight, and Mozilla Scalable Vector Graphics (SVG), which add animation and movies to Web pages. Compared to Java scripting, these plug-ins provide stunning graphics and animation for displaying quantitative information, which makes the user interfaces very appealing to business users. They load both visualizations and data simultaneously in a single file rather than dishing up dozens or hundreds of pages. Although this makes the initial load slower than a comparable DHTML or AJAX application, performance thereafter is exceptionally fast, since the data required to display all components on a page resides locally.

Vendor Advancements. BI vendors have been scrambling to meet increasing demand for visualization. For instance, Oracle's release of Oracle Business Intelligence Enterprise Edition (OBIEE) 11g in mid-2010 addressed visualization weaknesses in earlier releases, Oracle officials said. Vendors such as MicroStrategy, ADVIZOR Solutions, and Tableau Software have recently emphasized new in-memory capacity for greater scalability. SAS (with its JMP visualization software) and DSPanel are among vendors incorporating the open-source R statistical programming language to mix visualization and data mining.

Vendors are adding new functionality to visualization solutions.

Conda and Dundas, which both provide charting components and dashboard tools, have expanded their tool sets to give developers greater flexibility. Microsoft is aiming to elevate Excel's profile for BI visualization with the 2010 release of PowerPivot, an add-on that helps Excel accommodate large-scale data and extends its visualization capabilities, Microsoft officials said. Similarly, PowerPivot can leverage new visualization capabilities available through SharePoint 2010 integration with Visio, they said.

Many of these innovations are aimed at untethering business users from a reliance on IT so they can analyze data in a visual environment. "It's an evolutionary thing," said Doug Cogswell, president and CEO of ADVIZOR Solutions. "We're used to using BI to view reports or KPIs, and now people want to move beyond reporting to visual analysis."

Design and Development

Creating effective displays is challenging.

Dashboard Displays. Creating effective dashboard displays can be challenging, and developers seldom have sufficient background in visual design to do a good job. Devising optimal metrics, navigation, workflow, data-source infrastructure, and ensuring that data is relevant and actionable are equal challenges. "You can create a view that looks really nice, but it adds zero value if it lacks impactful information," said TerBush of Wyndham Exchange and Rentals.

For many organizations, research into dashboard design principles and iterative development with collaboration among designers and business users are keys to success. At the large U.S. bank mentioned earlier, the BI team leveraged lessons learned from previous dashboard-building exercises in delivering the company's highly successful productivity dashboard. "You need to stress what business questions the data and visualizations are trying to answer," the bank's VP/BI manager said. "You involve business users right from the beginning—that's critical in shaping the workflow and the questions you address."

Design Techniques. Companies use a variety of techniques to design dashboards, the most prevalent being prototyping dashboard screens with users (76% of respondents). Other techniques include reading visual design books (61%) such as Stephen Few's *Seeing is Believing* and *Information Dashboard Design* or Wayne Eckerson's *Performance Dashboards: Measuring, Monitoring, and Managing Your Business*.

Other design techniques include creating design templates (37%), attending classes (29%), leveraging vendor design templates (25%), hiring experts in visual design (21%), and testing designs in a usability lab (15%). (See Figure 12.)

Templates are particularly important if multiple dashboards are in place to ensure that users have a common and consistent experience. Usability labs are great ways to validate and refine designs, although a formal lab, whether insourced or outsourced, can be expensive. A cheaper alternative is to recruit a few willing users, sit them down in front of a newly designed visual environment, and give them a task to perform. Have them talk about their experiences using the tool as they work, describing what's easy and what's confusing.

Prototyping visual displays is popular and effective.

"We do a lot of prototyping, iteratively and in an evolutionary fashion," said Cuyjet of ARC. "We show it to customers, [and] get their reaction and what would they change as we move through the development cycle."

Which of the following techniques have you used when designing dashboard screens?

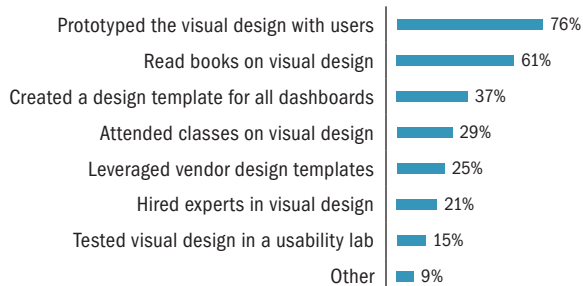


Figure 12. Based on 210 respondents.

Standards. At Kaleida Health, Gerena strives to give each metric its own visual “personality” so that users associate it with the data that it reflects. That means using a variety of visualization types and colors, and ensuring that each type is well suited to the data it portrays. For example, Kaleida uses a color-coded spiderweb chart (see Figure 13) to illustrate results of patient satisfaction surveys on 12 issues.

Metrics with visual “personality”

“It’s a rare type of chart, so when people see a spiderweb chart, I want them to associate it with patient satisfaction,” Gerena said. “It creates a mental shortcut for people if there’s some variation and a ‘personality’ that makes a metric stand out visually.”

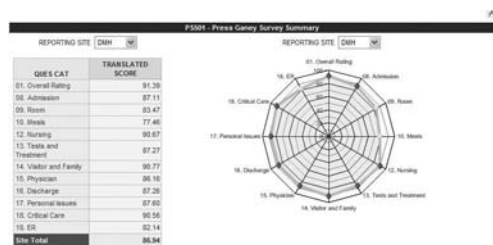


Figure 13. A spiderweb chart illustrates patient satisfaction ratings at Kaleida Health.

Cultural Influences. Effective dashboard design will take into account types of users, their thought processes, and the culture that prevails within the target business unit. Matching the right types of visualizations to the right audience can substantially increase user adoption of the dashboard.

For example, Los Angeles–based GUESS uses visuals of clothing and people to highlight its top 10 best sellers in apparel categories and engage its clothing designers, who are typically young and fashion-conscious individuals with little inclination to examine Excel spreadsheets. (See Figure 14.) “We felt we needed to make it more visually interesting to increase user adoption, just based on our corporate culture,” said Yen of GUESS. “Now I get feedback like, ‘Wow, it’s so easy to see how different patterns are selling, how different colors are taking off. It’s so great to have visibility into other sides of the business, because there’s a lot of competition across our divisions.’”



Figure 14. Dashboards for GUESS clothing designers use visuals of people and products.

The GUESS dashboard uses little in the way of conventional data visualization beyond the left-to-right ordering of skirts (the skirt on the left being the top seller, with the others in descending order). But it effectively and visually communicates information of keen interest to a product designer, such as color and fabric type, and it enables drill-through to examine sales by region, store, season, and so forth. These insights into the commercial success or failure of an item then drive the GUESS product design team’s decisions and priorities.

Developers. When it comes to developing visual environments, the largest share of respondents (41%) said that IT developers create dashboard screens, compared to 26% who said power users create the screens. (See Figure 15.) Interestingly, dashboards created by power users generate greater insight than those built by IT developers (see Figure 16). This is likely because power users are closer to business issues and often are users of the dashboards themselves.

Who develops the dashboard screens?

Dashboards built by power users deliver the greatest insight value.

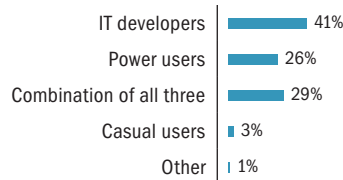


Figure 15. Based on 210 respondents.

Value by Dashboard Developer. More than 63% of organizations using dashboards built by IT developers realized “very high” or “high” insight improvements. On the other hand, 85% of dashboards built by power users deliver “very high” or “high” improvements to insights. (See Figure 16.) This reflects the effectiveness of engaging power users with both business and technical skills in the design of dashboards and determining the data they should display in which formats.

Value by personnel types developing dashboards

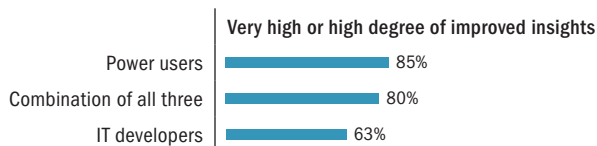


Figure 16. Based on 210 respondents.

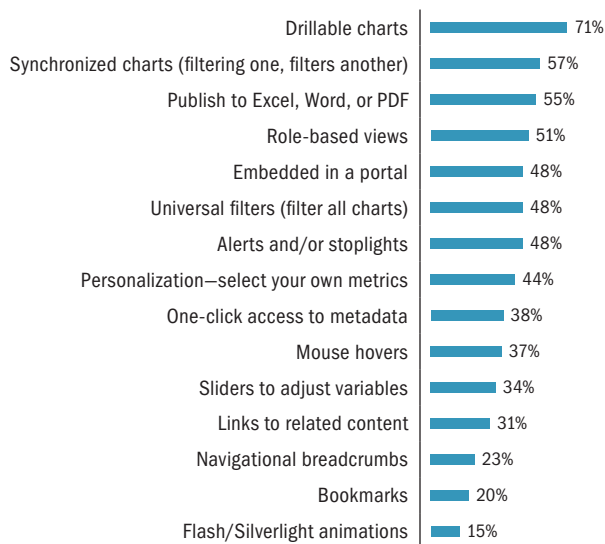
Visual Features and Functions. Our question on the importance of certain GUI characteristics generated some interesting results. By a substantial margin, drillable charts was the top-rated of 15 characteristics, cited by 71% of respondents as highly important to improving dashboard usability and reflecting the value of exploratory visual analysis. (See Figure 17.)

An appealing visual interface can serve to prompt analysis and insight to meet BI’s objective of improved business performance. “What we want to do is have our users discover and understand why there are outliers and exceptions,” said Gerena of Kaleida Health. “Attractive visualization is the lure, the bait, so they can easily spot issues and click through to explore the data.”

The second most important feature (cited by 57% of respondents) is synchronized charts, which link two charts with a single filter so that filtering results on one chart updates the pair. Interestingly, the ability to publish to Excel, Word, or PDF was considered highly important by 55% of respondents, illustrating that many users continue to use such familiar environments to analyze, display, and share data.

Role-based views were also high on the list (51% of respondents), as they can (a) promote efficiency and productivity by providing relevant information by user role, and (b) contribute to privacy and security with data access limited to authorized individuals. Other valued GUI features include embedded in a portal (48%), universal filters (48%), alerts/stoplights (48%), personalization (44%), one-click access to metadata (38%), sliders to adjust variables (34%), links to related content (31%), “navigational breadcrumbs” (23%), bookmarks (20%), and animations (15%).

To what degree do the following GUI techniques improve the usability of your dashboard?



Drillable charts are rated highly important to dashboard usability.

Figure 17. Based on 210 respondents who ranked the importance of GUI techniques as “high.”

Graph Types. To assess the prevalence of graph types, we asked respondents to characterize the percentage of certain graphical types in their BI user dashboard interfaces. We also asked them to characterize the degree to which each graph type helps users glean insights and make decisions. (See Figure 18.)

Prevalence and high value of visualization types

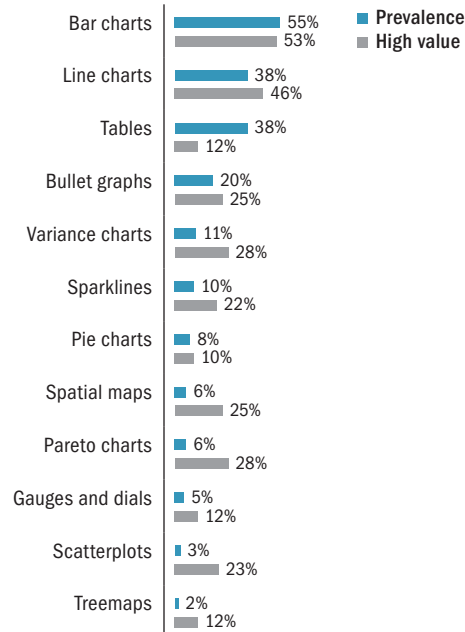


Figure 18. Prevalence is based on responses of “a great deal” or “a lot” to the question, “What % of your dashboard charts are X?” High value is based on responses of “high” to the question, “From your experience, how well does X help users glean insights and make decisions?” Based on 210 respondents.

Tried-and-true bar charts (55%) and line charts (38%) are the most common graph types used in dashboards, followed by (non-visual) tables (38%) and bullet graphs (20%). The bullet graph, created by Stephen Few, is one of the newest graph types, but it has clearly caught on quickly with dashboard designers and audiences. Other graph types include variance charts (11%), sparklines (10%), pie charts (8%), maps (6%), Pareto charts (6%), gauges and dials (5%), scatterplots (3%), and treemaps (2%).

Not surprisingly, the largest percentage of respondents (53%) also gave bar charts and line charts high value ratings (53% and 46%, respectively). Tables are the only graph type to have a lower value than prevalence at 12%. After bar and line charts, variance and Pareto charts offer the most value (28% each), followed by bullet graphs and spatial maps (25% each), scatterplots (23%), sparklines (22%), treemaps and gauges/dials (12% each), and pie charts (10%). Vendors have taken note of such preferences for practical, functional visualizations and have de-emphasized whiz-bang visual characteristics that were not uncommon several years ago. “We’ve cleaned up the charts, for less of the ‘wow’ factor in favor of a good, basic chart that conveys information quickly,” said Mardell Cheney, chief technology officer of Corda.

Despite the popularity of meat-and-potatoes graph types such as bar and line charts, organizations are beginning to exploit other graph types, although adoption takes time. “The first time I saw a heat map, I thought, ‘No one’s going to be able to understand these things,’” said Doherty of Dartmouth. In fact, she said, heat maps have proven “incredibly powerful” in their ability to combine and reflect multiple dimensions.

Recommendations

Here are some rules of thumb for incorporating visualization into your BI applications. These are adapted from the second edition of Wayne Eckerson’s book, *Performance Dashboards: Measuring, Monitoring, and Managing Your Business* (John Wiley & Sons, November 2010).

Focus on requirements first. Focus first on what information users need and how they plan to use the dashboard, rather than how they want to view the data it contains.

Deliver high-quality data. Populate the visual environment with high-quality data, or even the prettiest pictures won’t have any value for users.

Prototype. Get user feedback on the data and design before rolling into production.

Know your users. Different types of users—executives, managers, power users, and front-line workers—have different visualization requirements.

Recruit design experts. Don’t attempt visual design without an expert to guide you.

Iterate. You’ll never create the perfect design the first time, and needs and preferences change. So iterate continuously to improve and adapt your designs.

Less is more. Don’t clutter your displays with useless decoration or other content that obscures the most important messages that the data needs to convey.

Zero to three. Ideally, users should be able to view all pertinent data at a glance without clicking. Then, they should be able to view details of any top-level metric in three clicks or fewer.

Balance sparsity and density. Good visuals are sparse, showing only what’s necessary. Yet they are also dense, showing all information necessary. Balancing sparsity and density is an art.

Group related elements. One way to balance sparsity and density is to use tabs to group related data.

Evolution. Visual preferences change over time and as users become more familiar with the data and the visual environment. As a rule, design visual displays to be sparse at the start and then become denser over time.

Leverage templates. Create a standard look and feel with standard graph types, fonts, labels, and colors. Using templates is a great way to improve usability.



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