Data Storytelling - The 7 Design Principles for narrating an effective Data Story

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Abstract The data deluge poses a significant challenge: vast amounts of information often lack clear context and narrative, hindering actionable insights. This article explores data storytelling, the art of transforming data into compelling narratives that resonate with audiences and unveils 7 design principles to craft compelling data stories that resonate with audiences and inspire informed decisions. Learn how to leverage data context, visuals, and powerful narratives to guide your audience on a journey of insight. Discover tips for choosing the right visuals, maximizing data-ink ratio, applying Gestalt principles, and crafting actionable narratives that leave a lasting impact. Whether you're a business leader, analyst, or anyone seeking to harness the power of data, these principles empower you to turn information overload into transformative stories.

1. Introduction

The Data Deluge

The modern world generates data at an astounding rate. From social media interactions to manufacturing sensors, organizations across industries accumulate information at an unprecedented pace. However, a paradox often emerges: the more data, the less clarity. Spreadsheets become unwieldy, dashboards overflow with metrics, and insights get buried under mountains of raw numbers. This data deluge, encompassing sales figures, customer feedback, revenue metrics, and website analytics, often overwhelms executives seeking real-time, informed decision-making. Executives, faced with complex decisions, crave clear, concise narratives that translate data into actionable knowledge.

As a business transformation consultant specializing in data product management at tech companies, I have witnessed firsthand the debilitating effects of data paralysis. Executives bombarded with raw numbers and intricate charts often lack the context and narrative to translate data into actionable insights. While data analysts have unprecedented access to data, transforming it into a compelling narrative presents a distinct challenge. Many rely solely on tools like MS Excel, potentially obscuring or altogether missing the most captivating insights within their datasets. While modern tools leverage artificial intelligence to recommend output formats and even generate text, code, images, audio, and video, the responsibility of bringing data to life visually & contextually still rests with the data analyst or manager.

Data storytelling is the art of transforming cold, hard data into captivating narratives that resonate with business leaders. It involves weaving facts, figures, and visualizations into a clear, concise message that answers specific business questions [4]. This narrative approach makes complex data digestible, actionable, and memorable, empowering leaders to make informed decisions.

Data stories leverage the human brain's natural affinity for narratives. They tap into emotions, spark curiosity, and make information relatable. Instead of presenting an avalanche of numbers, data stories paint a picture –

showcasing trends, highlighting anomalies, and revealing hidden connections. This human-centric approach resonates with executives, who can readily connect the dots and make data-driven decisions with confidence. A good data story has 3 critical components: Data Context, Visual Analytics, and a Powerful Narrative. [1]

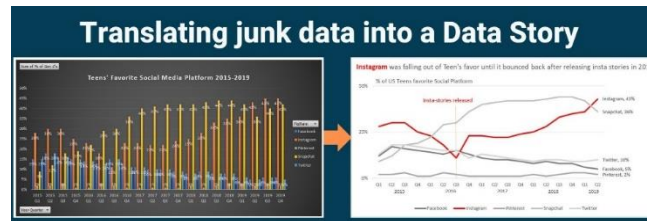Consider the below example of the diagram where there are two charts shown side by side.

Figure 1: Translating junk data into a Data Story

The first chart attempts to convey the evolution of teens preferred social media platforms between 2015 and 2019. However, despite analyzing five platforms, it presents significant challenges in interpreting the data. This lack of clarity renders it functionally indistinguishable from "junk data." Conversely, the second chart effectively communicates the intended narrative. Key data points are readily inferred, including:

- Data Context: The chart tracks teens' social media platform preferences from 2015 to 2019.
- Visual Representation: A clear visualization highlights Instagram's trajectory, while other platforms are de-emphasized.
- Narrative: Instagram initially lagged competitors but experienced a resurgence following the launch of Insta-stories in 2016.

This second chart serves as an example of effective data storytelling. This article outlines the seven design principles that can guide analysts in crafting similarly compelling narratives from your data.

2. The 7 Design Principles for Narrating an Effective Data Story
The 7 Design Principles given below effectively weave the data context, visuals, and narration to craft an amazing data story that all the audience members can interpret in the same way without confusion.

A. Determine the Data Context through Story boarding

The urge to dive straight into visualization when crafting a data story is understandable. However, effective storytelling begins with a solid foundation: data context. Establishing this context ensures our narrative resonates with our audience and provides the "why" and "how" behind the data.

1) Lay the Groundwork:
- Know Your Audience: Understanding who you're communicating with is crucial. Are they familiar with the data and trust your expertise? Or do they need introductory context before diving into the story? Tailoring your narration to their existing knowledge and expectations is the key.
- Anticipate Expectations: What does your audience hope to gain from the data? What questions do they have? Knowing their expectations allows you to focus on relevant information and make it clear why your story matters. [2] Avoid assuming they'll connect the dots on their own.
- Leverage Data for Impact: Once you understand your audience, consider how best to use data to tell your story. Emphasize the primary evidence and distinguish it from supporting details. The tone and format may differ depending on whether you're presenting live or via email.

2) Storyboarding for Clarity:
- Ask Clarifying Questions: Before embarking on analysis, ask questions to refine your understanding of the "why" and "how" behind the story. This fosters a compelling narrative.

- Focus on Explanatory Insights: While exploratory analysis uncovers trends and outliers, keep your storytelling focused on the "why" – the explanations that answer the audience's questions and provide actionable insights [5].
- Create a Storyboard: Storyboarding serves as a visual roadmap for your narrative. Sketch out the key messages, data points, and visuals you plan to use. This helps maintain a clear flow and avoid losing sight of your core message.[7]

B. Choose the right Visual

Data visualization is a nuanced art, offering a multitude of ways to represent information. However, a surprisingly small number of chart types dominate the field. In fact, studies suggest that over 90% of the time, analysts rely on just twelve key charts to communicate their findings [6]. Below is a summary of the twelve most frequently used charts along with their ideal applications:
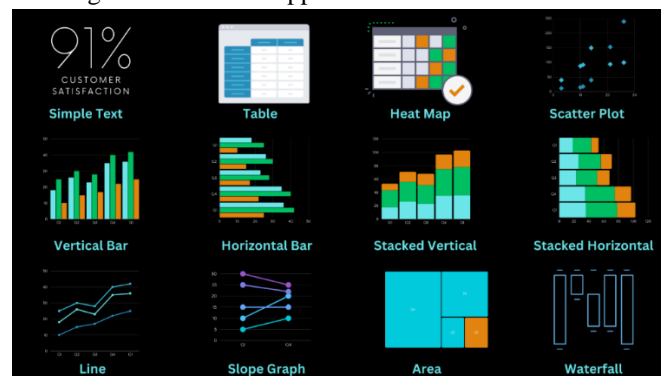

Figure 2: The 12 Charts used 90% of the time.

- Simple Text – Ideal when you want to highlight only 1 number & omit other misleading info.
- Table – for a mixed audience, each interested in reading their own row of data.
- Heat Map – represents data as color gradients, useful for exploring large datasets and identifying areas of high or low values.
- Scatter Plot – for revealing relationships between two variables, ideal for identifying correlations.
- Vertical Bar - for comparing incremental differences between categories.
- Horizontal Bar – for incremental differences between categories with long names.
- Stacked Vertical Bar -to compare totals across categories and see the subcomponent pieces within a given category.
- Stacked Horizontal Bar - to compare totals across categories with long names and see the subcomponent pieces within a given category.
- Line Chart – for showcasing trends and changes over time, when comparing multiple variables.
- Slope Graph – for comparing relative change between two-time periods.
- Area Graph – for visualizing numbers of vastly different magnitudes
- Waterfall – to Illustrates the cumulative effect of sequential positive and negative values, visually explaining the change from a starting point to an ending point.

Charts to avoid: Pie Chart, Donut, and 3D Charts.

Humans are not good at perceiving angles and areas. Therefore, Pie Charts, Do-Not Charts and 3 D Charts can lead to confusion and miss-interpretation of data. Pie Charts could be replaced with Bar Charts. If you must use, pie-charts for some reason, refrain from using mor than 5 slices and order the slices either in clockwise or anti-clockwise directions. Choosing the most effective visual is an iterative process. Experiment, consider your audience, and align your chart with the specific story you want to tell.

C. Maintain a High Data-Ink Ratio for the Visuals

An important element of a good data story is that every element of the visualization should help in conveying the data story. The more "ink" is spent on unnecessary embellishments, the less space is available to paint the true picture of the data. The Data-Ink Ratio is defined as

$$\frac{\text{Ink on Data Elements}}{(\text{Ink on Data Elements} + \text{Ink on Non-Data Elements})}$$

Data Elements represent the data points or trends in the visualization such as Lines in line charts, Bars in bar charts, Dots in scatter plots etc. Non-Data Elements represent elements that do not directly represent the data itself such as the Gridlines, Chart borders, Decorations, Legends (if non-essential), Chart titles (if redundant with labels) etc. [8]

For Example, if you analyze the two charts provided in Figure 1, the 1st chart on the left has high ink on non-data elements, which makes it look cluttered and difficult to interpret; whereas the 2nd chart on the right has high ink on a data element - a line highlighted only for one category (Instagram) in red, leading to increased emphasis on the Instagram category, helping communicate an effective data story.

The goal of a good data story is to have a high data-ink ratio, which means minimizing non-data elements while maximizing the visual emphasis on the actual data. A high data-ink ratio improves:
- Clarity: as the focus remains on the data, making it easier for viewers to understand message.
- Efficiency: as it avoids visual clutter and cognitive overload.
- Impact: as it emphasizes important trends and patterns, letting viewers draw same conclusions

D. Apply Gestalt's Principles of Design to the Visuals

The visual elements of an effective data story need to engage users and convey insights. To ensure these elements work together harmoniously, Gestalt principles of design can enhance your narrative. Gestalt's Principles are rooted in the philosophy that that our brains perceive visual information as a whole, seeking patterns and organization rather than focusing on individual elements. For data storytelling, understanding of the following six Gestalt's principles is crucial:
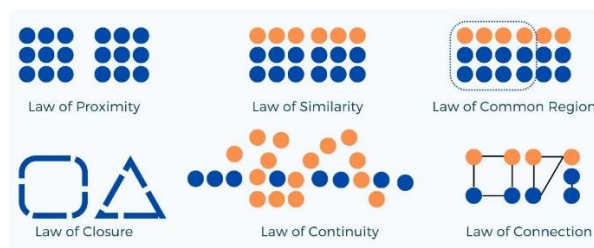

Figure 3: Gestalt's Principles of Design

- Law of Proximity: Elements close together are perceived as belonging together. Use this to visually group related data points, trends, or categories within your chart or infographic.
- Law of Similarity: Elements sharing similar visual characteristics (color, size, shape) are seen as related. Leverage this to highlight comparisons, patterns, or outliers by using consistent aesthetics.
- Law of Common Region: Elements located within the same closed region are perceived as being grouped together. Leverage this to group related information or create sections within your design.
- Law of Closure: We naturally complete incomplete shapes or patterns. Utilize this to create subtle suggestions or lead viewers to infer missing information within the data story.

- Law of Continuity: Our eyes tend to follow visual paths and patterns. Use lines, curves, or color gradients to guide viewers eye towards key elements to create a narrative flow.
- Law of Connection: Elements that are connected to each other by color, lines, frames, or other means are perceived as more related and grouped than elements with no connection.

Gestalt principles applied correctly benefit data storytelling through:
- Enhanced Comprehension: Clearer organization and relationships between elements lead to faster and easier understanding of complex data.
- Increased Engagement: Visually appealing and cohesive design keeps viewers engaged and interested in the story.
- Memorable Insights: Well-applied Gestalt principles help viewers retain key information and takeaways from your data narrative.
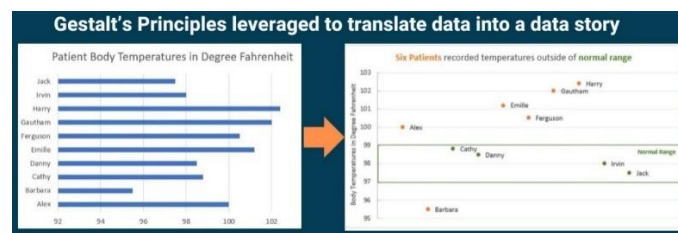

Figure 4: Gestalt's Principles applied to translate a chart into a data story

Consider Figure 4, which contrasts two visualizations of patient body temperatures. The first chart presents data for ten patients but fails to convey meaningful insights regarding their temperatures. This lack of clarity hinders interpretation and effectively renders the visualization ineffective.

In contrast, the second chart demonstrates the successful application of Gestalt principles, including similarity, common region, and closure. This results in a clear and compelling data story: six out of the ten patients recorded body temperatures outside the normal range.

E. Expand Whitespace and Eliminate Chart Junk
Whitespace plays a crucial role in data storytelling by eliminating clutter and enhancing clarity in visuals and charts. It is the silent hero of any data narrative, which ensures that the main message shines through without overwhelming with Chart Junk – the elements of a chart that do not add value to the data being presented but rather serve to distract. Here's why whitespace is so important:

- Reduces Cognitive Load: A chart overloaded with data points, gridlines, labels, and decorations, such as the 1st chart in Figure 1, forces the audience to work harder to understand the message. Whitespace provides breathing room, allowing audience to focus on essential information.
- Highlights Key Points: By strategically using whitespace around key data points or trends, you create visual emphasis similar to putting a spotlight on the main actors in a data play.
- Improves Readability: Whitespace around labels and text elements makes them easier to read and understand. It eliminates the struggle of squinting at tiny labels crammed between data points.
- Creates a Sense of Hierarchy: Whitespace can be used to create a hierarchy of information, guiding the viewer's eye through the most important elements first.
- Enhances Aesthetics: Whitespace can create a sense of balance & elegance in visuals. A well-designed chart with appropriate whitespace feels more professional & polished.

Whitespace is a powerful tool in the data storytelling arsenal. Test different layouts and see what resonates with your audience. Below is an example of how whitespace can be leveraged to create clear, concise, and impactful visuals that truly engage audience and leave a lasting impression.
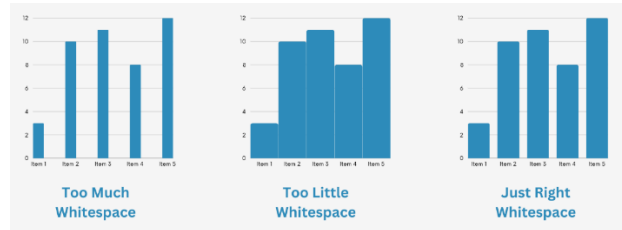
Figure 5: Illustrative Example for effective whitespace usage

F. Guide the narration through Design Affordances & Accessibility

To build an effective data story that goes beyond simply presenting information and crafts a narrative that engages and compels action, the elements of design affordances, accessibility need to work in harmony.

Affordances refer to the inherent usability cues within a data visualization that guide attention and promote interaction such as leveraging size, color, and placement to highlight key elements and leading the viewer's eye through the story or using drilldowns for deeper data exploration. Affordances are the invisible hand subtly directing your audience towards deeper understanding and engagement.

Accessibility ensures that the data story reaches everyone, regardless of their abilities. It implies that even if the audience members have different visual, auditory, and cognitive abilities, the visualizations and the data story are interpreted in a clear and concise manner by all. The best example of visualization with exceptional accessibility is the Metro Subway Map, which is used by all metros across the world, as it ensures that the map resonates with widest possible audience.

G. Craft an Actionable Narrative leveraging the Power of Repetition

Effective data storytelling transcends mere information transmission; it compels audiences to act [9]. This article explores three key components analysts should focus on to craft actionable narratives:

- Design Action-Oriented Titles

Start with a compelling title that clearly conveys the story's key takeaway and its relevance to the audience. This sets stage for informed decision-making and guides viewers towards specific actions.

- Leverage the power of repetition!

Strategically repeat your central message throughout the narrative. Begin by clearly stating the story's core finding, then delve into the supporting evidence, and conclude by concisely reiterating the key takeaway. This reinforces understanding and drives home the desired action. Emphasize key takeaways visually: Use bold text, larger fonts, or contrasting colors to highlight crucial elements and reinforce the message. This transforms your data story from informative to transformative.

- Embrace the Call-To-Action loop!

Choose the narrative structure that best suits your audience:

a. A Chronological Story: Begin with the problem, explain data analysis, and conclude with findings and solutions. This approach builds credibility with unfamiliar audiences.

b. The Call-to-Action Loop: Start with the desired action, followed by the data story and concluding with recommendations. This action-oriented approach is suitable for most situations, fostering emotional connection and driving action.

By crafting action-oriented narratives that strategically leverage repetition and call-to-action loops, we empower data to not only inform but also inspire real change. This is the true power of data storytelling, leaving a lasting impact beyond mere visualization.

3. The 7 Design Principles in Action: A Use Case

This section presents a practical case study demonstrating how applying the seven design principles outlined in this paper transforms an initially unclear bar chart (Figure 1, left) into a compelling data story capable of motivating action. The chart, originally depicting the evolution of teens preferred social media platforms from 2015 to 2019, lacked sufficient clarity and engagement. By strategically applying the seven design principles, we achieved a significantly more impactful visualization.

Figure 6: Use Case: Translating a Chart into a Data Story leveraging the 7 Design Principles

4. Conclusion

The ability to tell stories with data has become a highly sought-after skill. Whether communicating research findings, securing funding for a non-profit, or simply connecting with customers, an effective data story can be the difference between success and failure. Data storytelling empowers data to not only inform but also inspire action. Data storytelling represents a shift in strategic mindset, requiring a focus on the "why" behind the data, understanding the audience's needs, and crafting a narrative that compels action.

By applying the seven design principles outlined in this article, analysts can transform raw data into compelling narratives that resonate with audiences, driving informed decision-making and meaningful change. These principles emphasize clarity, visual effectiveness, accessibility, and strategic messaging, ensuring that data stories not only inform but also ignite action. Whether it's influencing business decisions, captivating customers, or driving social change, data storytelling has the power to unlock the true potential of data, leaving a lasting impact far beyond mere visualization.

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