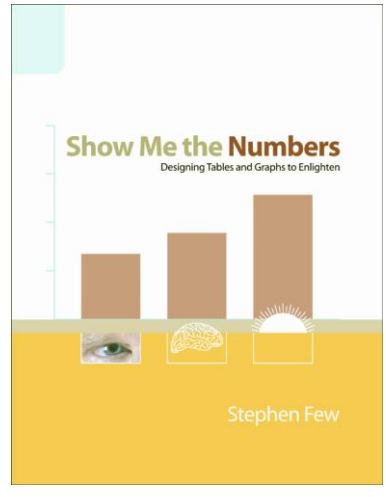
Graph Design
for effective communication

Stephen Few
of
Perceptual Edge



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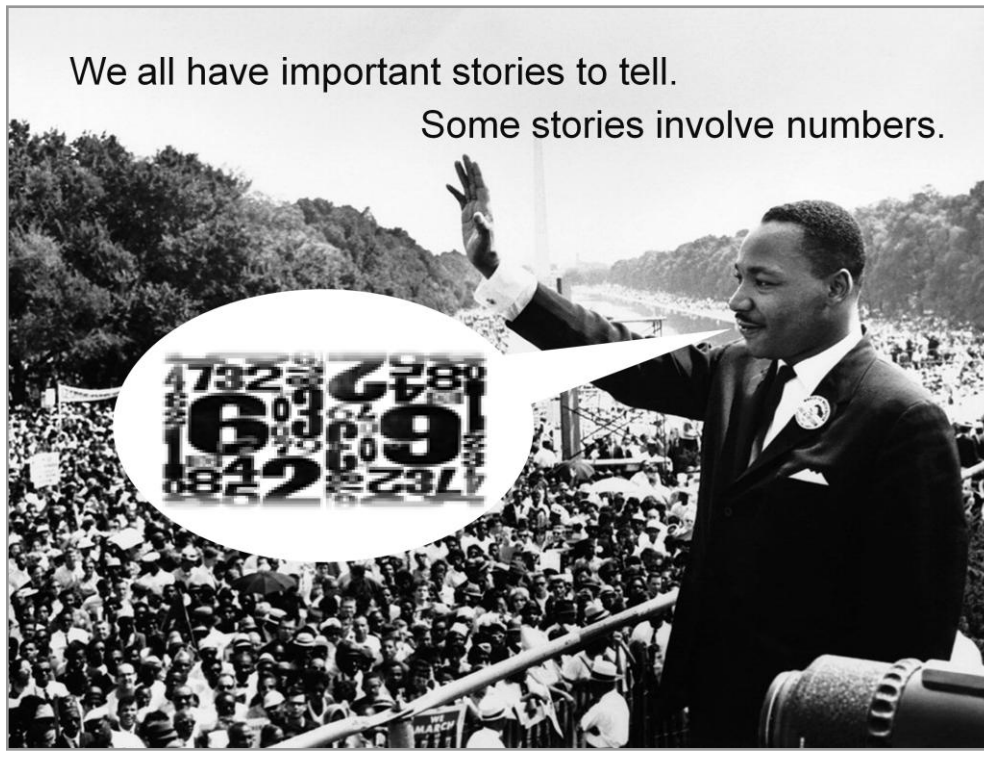

I work with people and organizations of all types. If they've requested my services, they have one thing in common—they all have important quantitative information to present, and they recognize they could be doing it much better.

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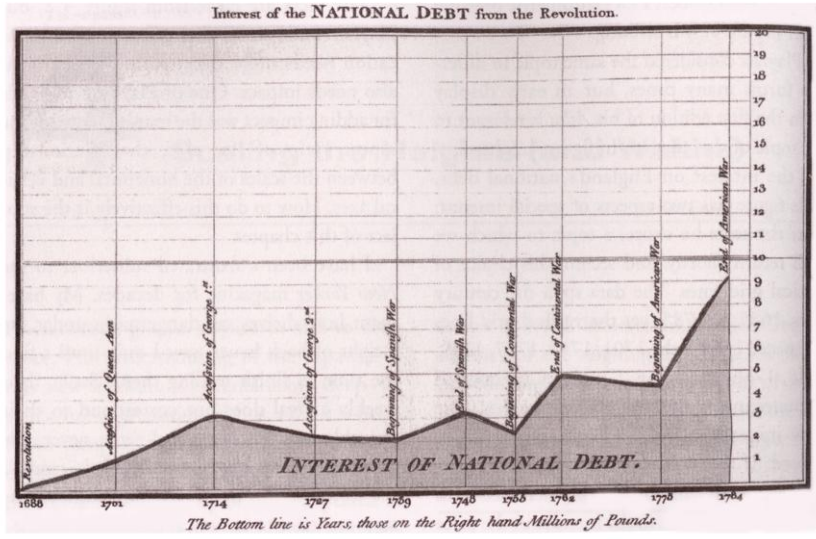
We've been telling them with graphs for quite awhile.



William Playfair – 1786

In 1786, a roguish Scot – William Playfair – published a small atlas that introduced or greatly improved most of the quantitative graphs that we use today. Prior to this, graphs of quantitative data were little known.

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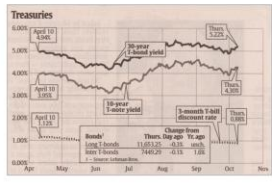
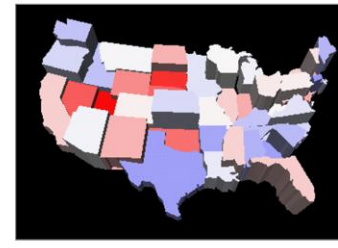
Graphs are now commonplace.





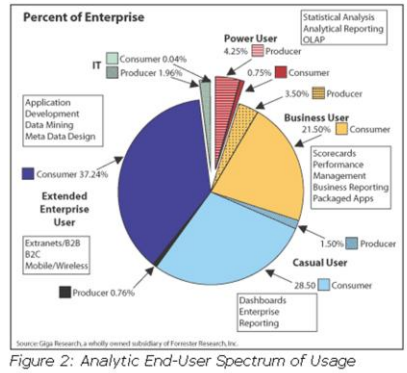


Figure 2: Analytic End-User Spectrum of Usage

Today, 220 years later, partly due to the arrival of the PC, graphs are commonplace, fully integrated into the fabric of modern communication. Surprisingly, however, Playfair's innovative efforts – sprung from meager precedent – are still superior to most of the graphs produced today.

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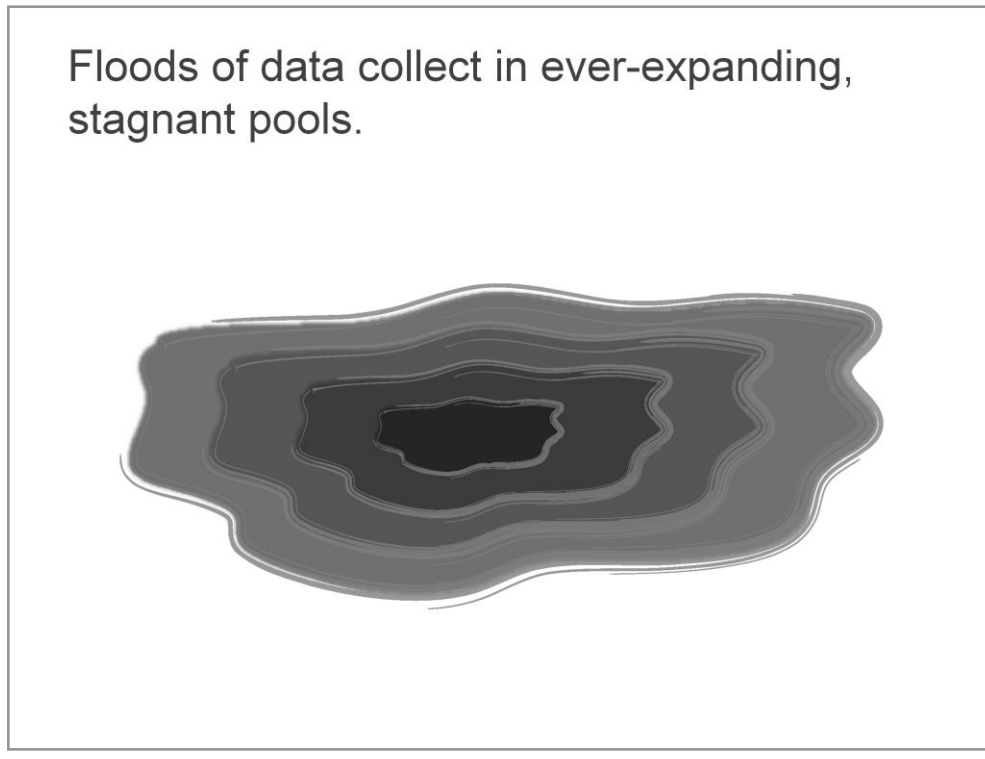

We live in the so-called information age. We have far more data than we've ever had, but our ability to make good use of it hasn't caught up. Information is useless until we understand what it means and can clearly communicate that meaning to those who need it, those whose decisions affect our world.

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A powerful language—

data visualization

—is largely being wasted!

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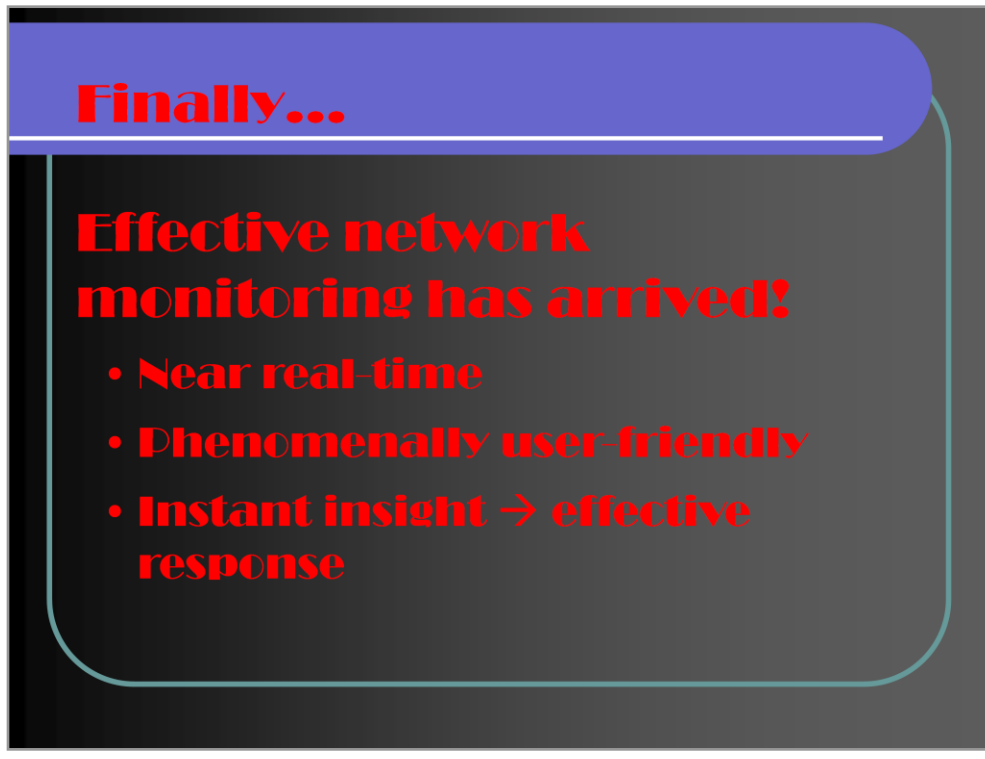

Imagine for a moment that you have just sat down in a conference room for your last meeting of the week. It's a Friday afternoon, and you're exhausted. You're one of many managers in the Information Technology department. Like most meetings, this one begins with the light of a projector suddenly illuminating a screen. Bursting with excitement, the speaker announces that he's going to introduce a brand new report that will be sitting on your desk when you arrive every morning, which will at last give you insight into what's happening with the systems that you manage. No longer will you be in the dark. The data will be up-to-date and easy to understand. You'll be able to take immediate action if something needs to be done. Without any further ado, here's your new report.

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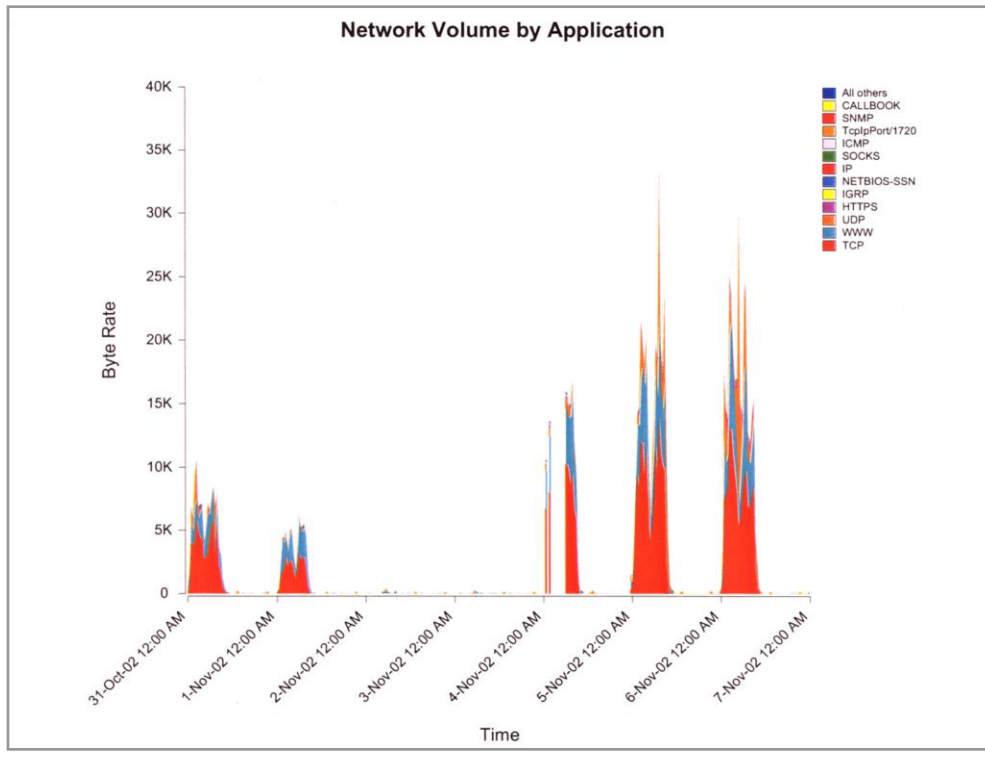

You stare at this graph very intently, but with increasing agitation as you try to keep any hint of confusion from crossing your face. From your peripheral vision you can see that the others in the room are smiling broadly and nodding with apparent understanding and approval. You feel very dumb. What you don't realize is that you are not alone. No one can make sense of this graph.

This very graph actually was distributed at my last place of corporate employment. It was at that time that I realized we had a problem.

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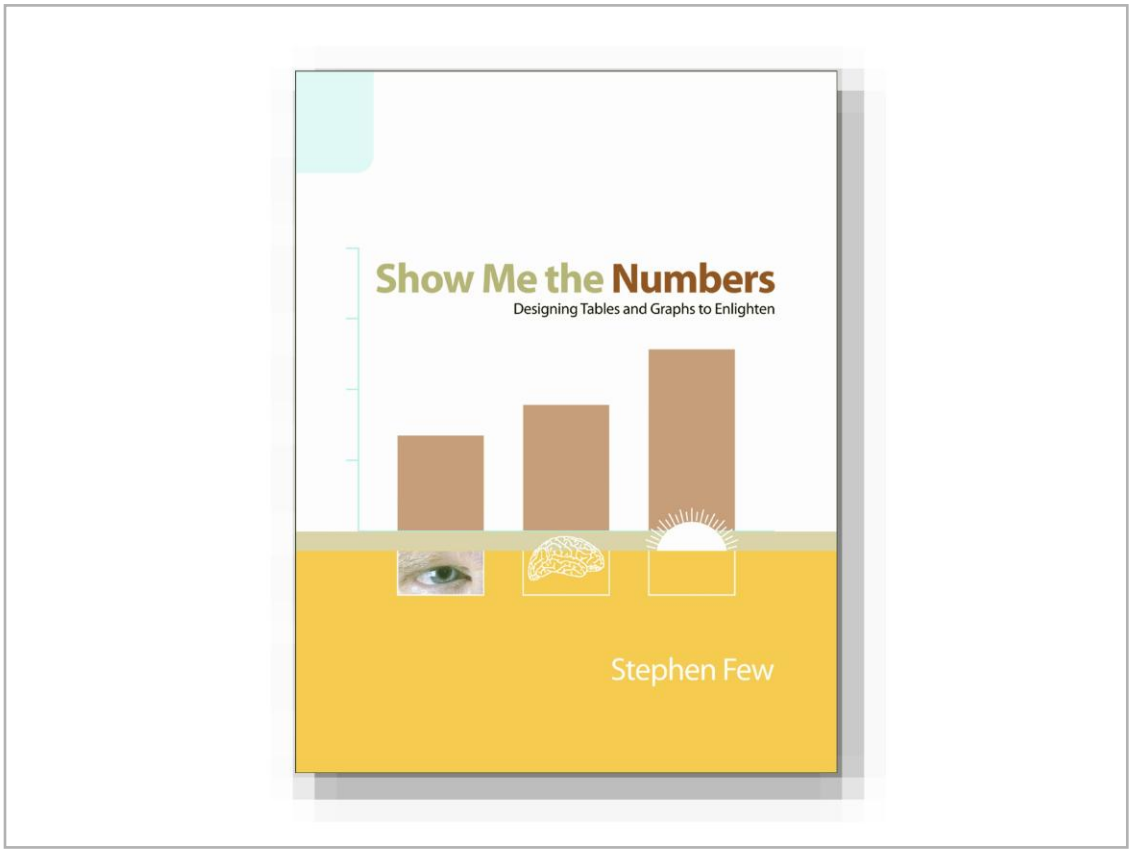

In 2004, I wrote the book ***Show Me the Numbers: Designing Tables and Graphs to Enlighten*** to help people like you respond in practical ways to the challenges that you face every day when presenting quantitative information.

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We are buried in data.

"Just show me the numbers!"

The phrase, "Just show me the numbers," was one that I heard from time to time on the lips of business people, especially those responsible for sales organizations, who were always frantic to know how sales were doing. They couldn't afford to wade through lengthy reports and unnecessary detail; they just want to see the important numbers right now!

Everyone is scrambling for metrics, key performance indicators (KPIs), scorecards, and digital dashboards. Quantitative data is what we rely on most to measure the health of our organizations, to identify opportunities, and to anticipate the future.

Despite great progress in our ability to gather and warehouse data, we're still missing the boat if we don't communicate the numbers effectively. Contrary to popular wisdom, information cannot always speak for itself.

You can spend millions of dollars to build the most robust and pristine data warehouse in the world, running on the most powerful hardware, and accessed by state-of-the-art software, but if the people who work with the data don't know how to make sense of it or how to present it clearly to decision makers, your investment is wasted.

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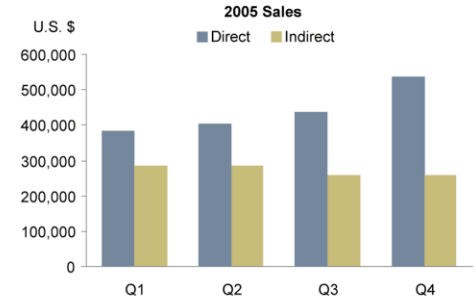
Quantitative information is primarily communicated through tables and graphs.

	Expenses			
Department	Jan	Feb	Variance	Change %
Sales	9,933	9,293	-640	-6%
Marketing	5,385	5,832	+447	+8%
Operations	8,375	7,937	-438	-5%
Total	$23,693	$23,062	-$1,327	-3%



But few communicate effectively. Why?

Why? Few people are trained.

Why? Few people recognize the need.

Why? Few examples of good design exist to expose the problem.

“Poor documents are so commonplace that deciphering bad writing and bad visual design have become part of the coping skills needed to navigate in the so-called information age.” Karen A. Schriver, *Dynamics in Document Design*, John Wiley & Sons, Inc., 1997.

“The public is more familiar with bad design than good design. It is, in effect, conditioned to prefer bad design, because that is what it lives with. The new becomes threatening, the old reassuring.” (Kevin Mullet and Darrel Sano, *Designing Visual Interfaces*, Sun Microsystems, Inc., 1995 – quoting Paul Rand, *Design, Form, and Chaos*)

Effective communication is not always intuitive – it must be learned.

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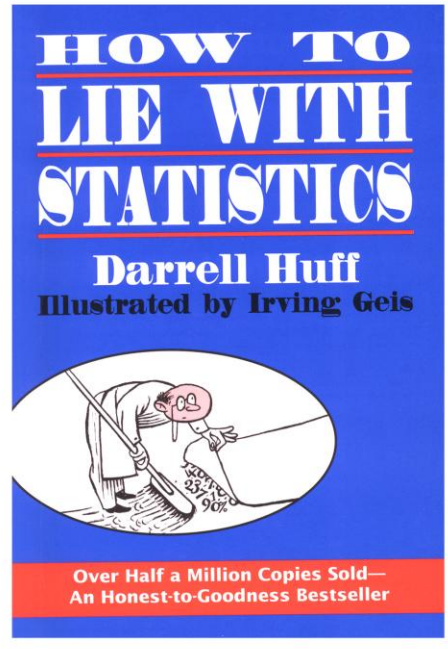
Intentional deceit is no longer our biggest problem.



In 1954, Darrell Huff wrote his best-selling book about how people were often intentionally using statistics, including graphs, to spread misinformation, especially in favor of their own products or causes. Today, vastly more misinformation is disseminated unintentionally because people don't know how to use charts to communicate what they intend.

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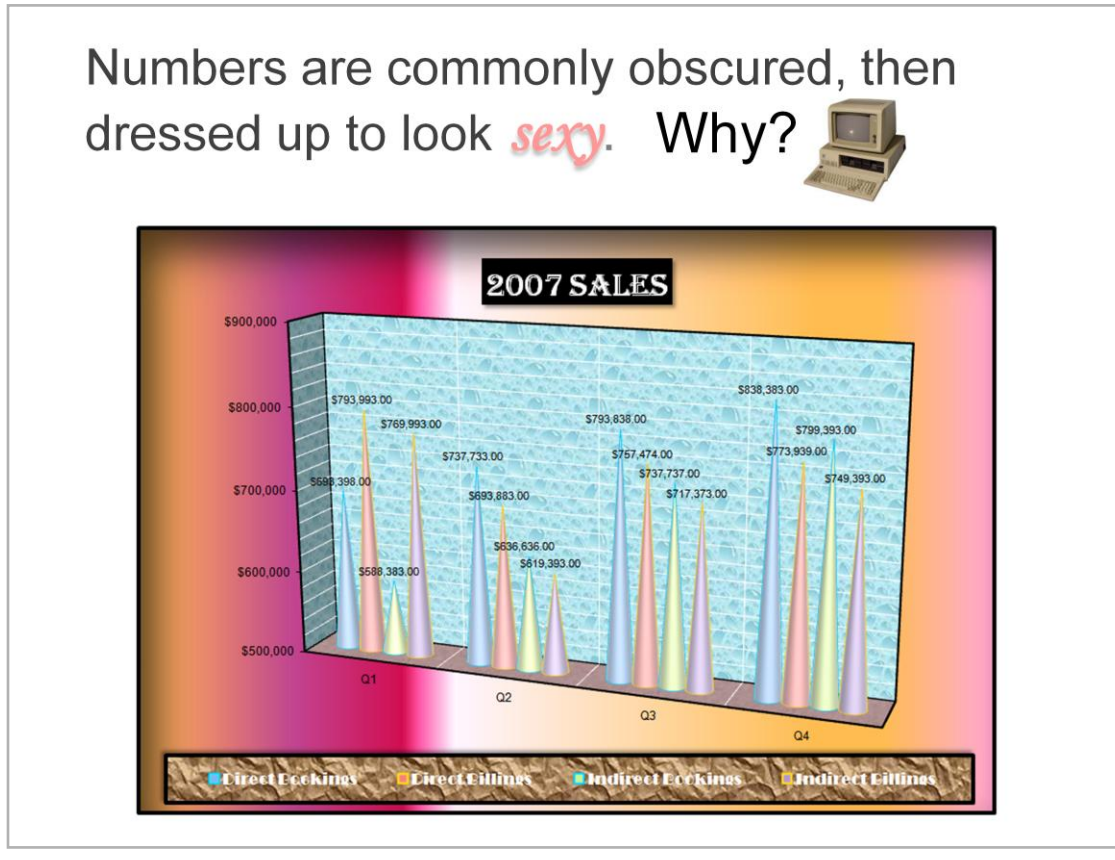

When the PC was introduced, software soon made the arduous task of table and graph creation as easy as 1-2-3 (literally “Lotus 1-2-3”, the software that was the first to legitimize the PC as a viable tool for business). Unfortunately, this improvement in ease and efficiency was not accompanied by instruction in visual design for communication. People today think that if they know how to click with the mouse to create a table or graph, they know how to present data effectively.

“In the two centuries since [the invention of the first graphs], …charts have become commonplace. With the advent of modern computer tools, creating graphs from data involves trivial effort. In fact, it has probably become too easy. Graphs are often produced without thought for their main purpose: to enlighten and inform the reader.” Jonathan G. Koomey, *Turning Numbers into Knowledge*, Analytics Press, 2001

I can talk about this all day, but the best way to make my point convincingly is to show you.

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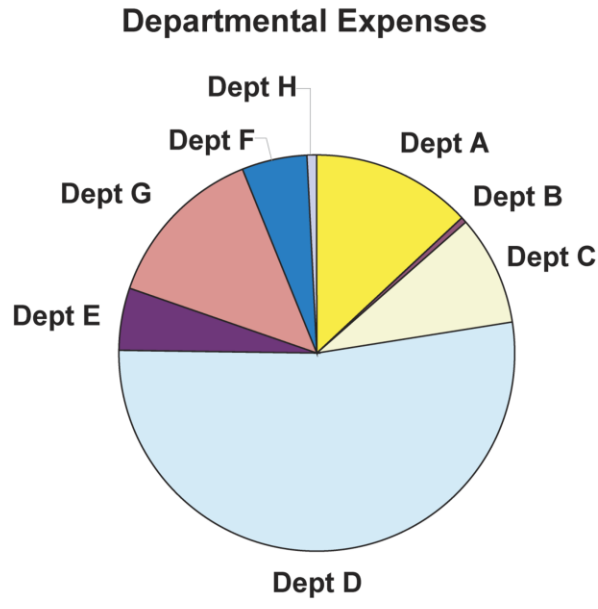
Example #1



The purpose of this graph is to display how *Department G* is doing regarding expenses compared to the other departments. Is the message clear?

Often, when someone creates a graph that appears inadequate somehow, they try to fix it with sizzle, as in the next slide.

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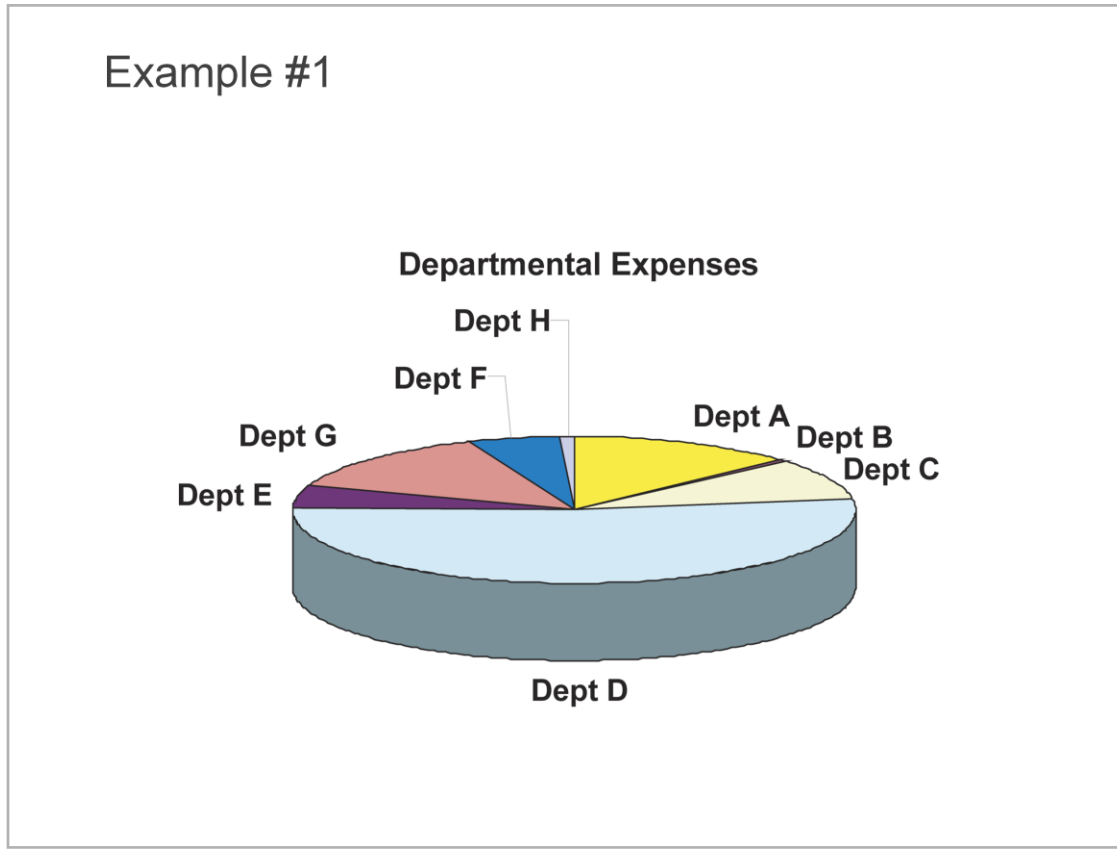

Does the addition of 3D improve this pie chart? Definitely not. In fact, it actually makes it harder to read.

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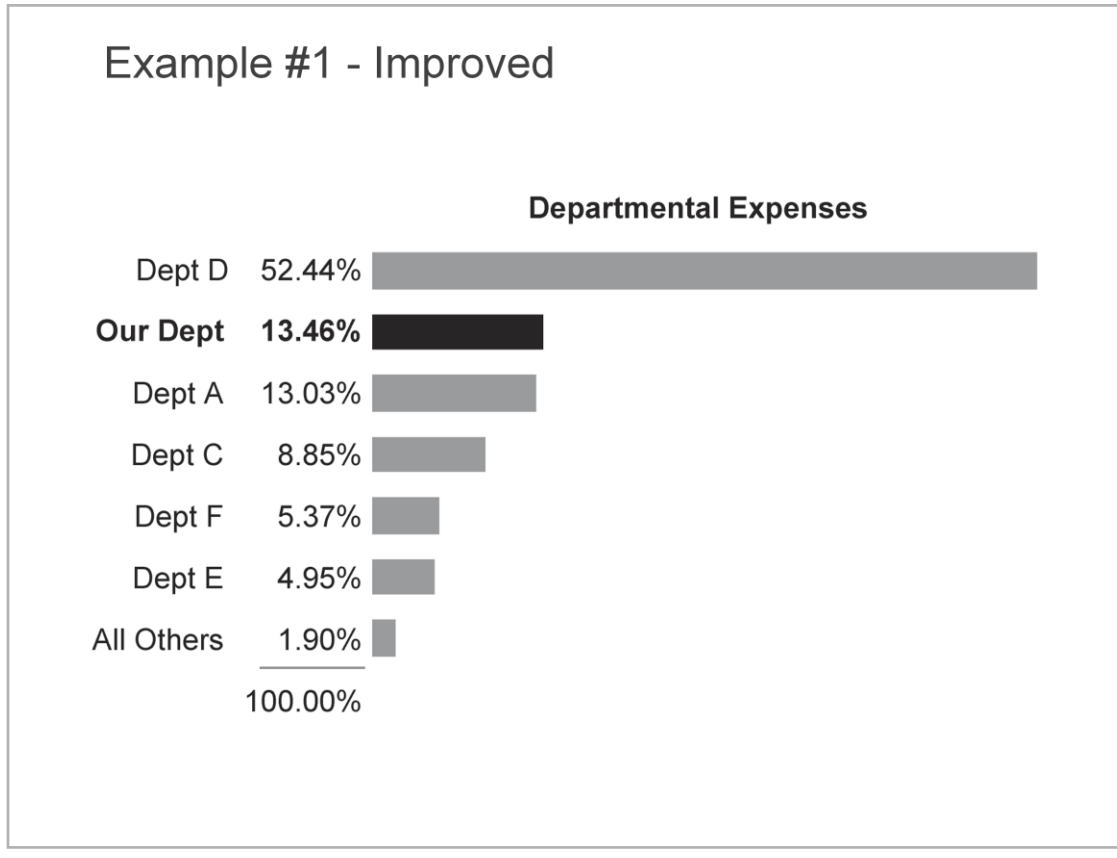

On the other hand, though it lacks flash and dazzle, this simple bar graph tells the story elegantly.

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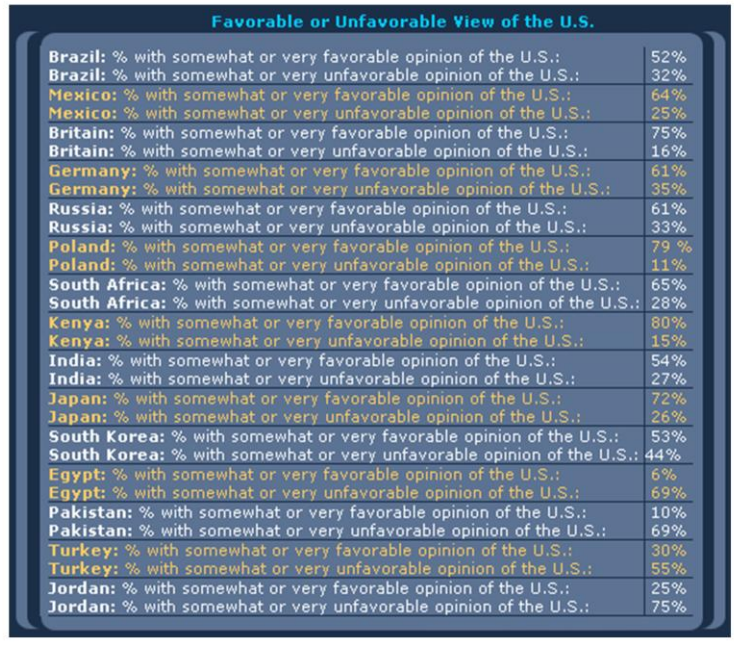
Example #2



Favorable or Unfavorable View of the U.S.

Brazil: % with somewhat or very favorable opinion of the U.S.:	52%
Brazil: % with somewhat or very unfavorable opinion of the U.S.:	32%
Mexico: % with somewhat or very favorable opinion of the U.S.:	64%
Mexico: % with somewhat or very unfavorable opinion of the U.S.:	25%
Britain: % with somewhat or very favorable opinion of the U.S.:	75%
Britain: % with somewhat or very unfavorable opinion of the U.S.:	16%
Germany: % with somewhat or very favorable opinion of the U.S.:	61%
Germany: % with somewhat or very unfavorable opinion of the U.S.:	35%
Russia: % with somewhat or very favorable opinion of the U.S.:	61%
Russia: % with somewhat or very unfavorable opinion of the U.S.:	33%
Poland: % with somewhat or very favorable opinion of the U.S.:	79 %
Poland: % with somewhat or very unfavorable opinion of the U.S.:	11%
South Africa: % with somewhat or very favorable opinion of the U.S.:	65%
South Africa: % with somewhat or very unfavorable opinion of the U.S.:	28%
Kenya: % with somewhat or very favorable opinion of the U.S.:	80%
Kenya: % with somewhat or very unfavorable opinion of the U.S.:	15%
India: % with somewhat or very favorable opinion of the U.S.:	54%
India: % with somewhat or very unfavorable opinion of the U.S.:	27%
Japan: % with somewhat or very favorable opinion of the U.S.:	72%
Japan: % with somewhat or very unfavorable opinion of the U.S.:	26%
South Korea: % with somewhat or very favorable opinion of the U.S.:	53%
South Korea: % with somewhat or very unfavorable opinion of the U.S.:	44%
Egypt: % with somewhat or very favorable opinion of the U.S.:	6%
Egypt: % with somewhat or very unfavorable opinion of the U.S.:	69%
Pakistan: % with somewhat or very favorable opinion of the U.S.:	10%
Pakistan: % with somewhat or very unfavorable opinion of the U.S.:	69%
Turkey: % with somewhat or very favorable opinion of the U.S.:	30%
Turkey: % with somewhat or very unfavorable opinion of the U.S.:	55%
Jordan: % with somewhat or very favorable opinion of the U.S.:	25%
Jordan: % with somewhat or very unfavorable opinion of the U.S.:	75%

I found this table on the Web site for Bill Moyers' public television show "Now". I felt that it provided important information that deserved a better form of presentation. In this case the story could be told much better in visual form.

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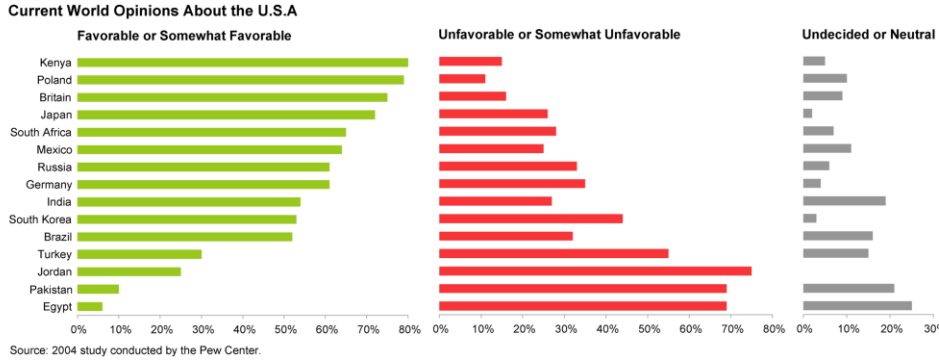
Example #2 - Improved



This series of related graphs tells the story in vivid terms and brings facts to light that might not ever be noticed in the table.

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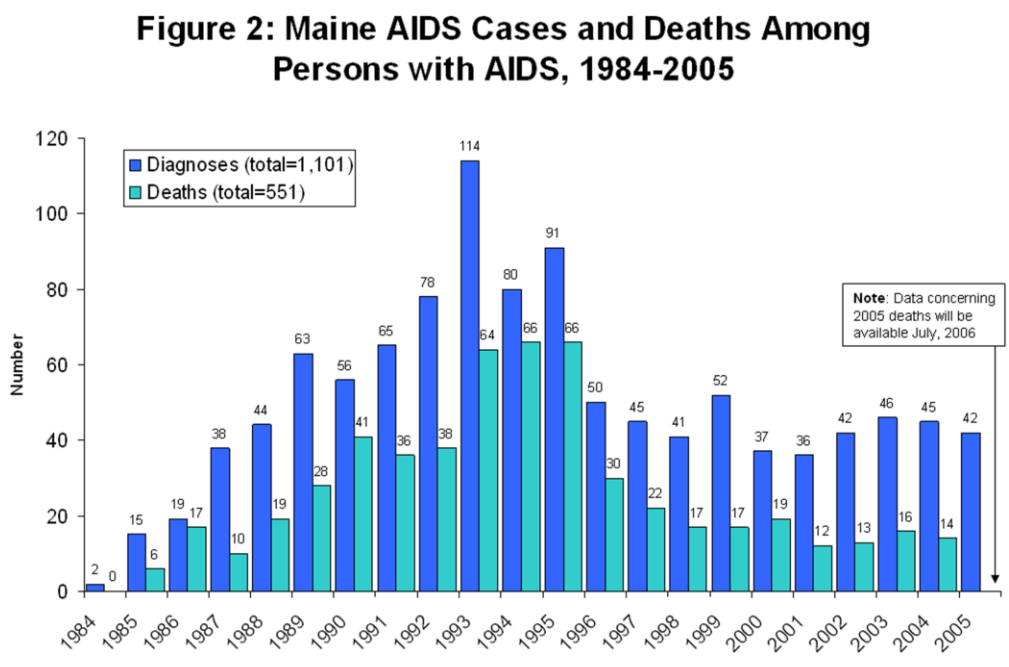
Example #3



Here's a public health example from the state of Maine. This graph contains important patterns that are difficult to discern due to clutter. It's hard to independently discern the patterns of change through time of diagnosed AIDS cases vs. deaths or to compare these patterns to one another.

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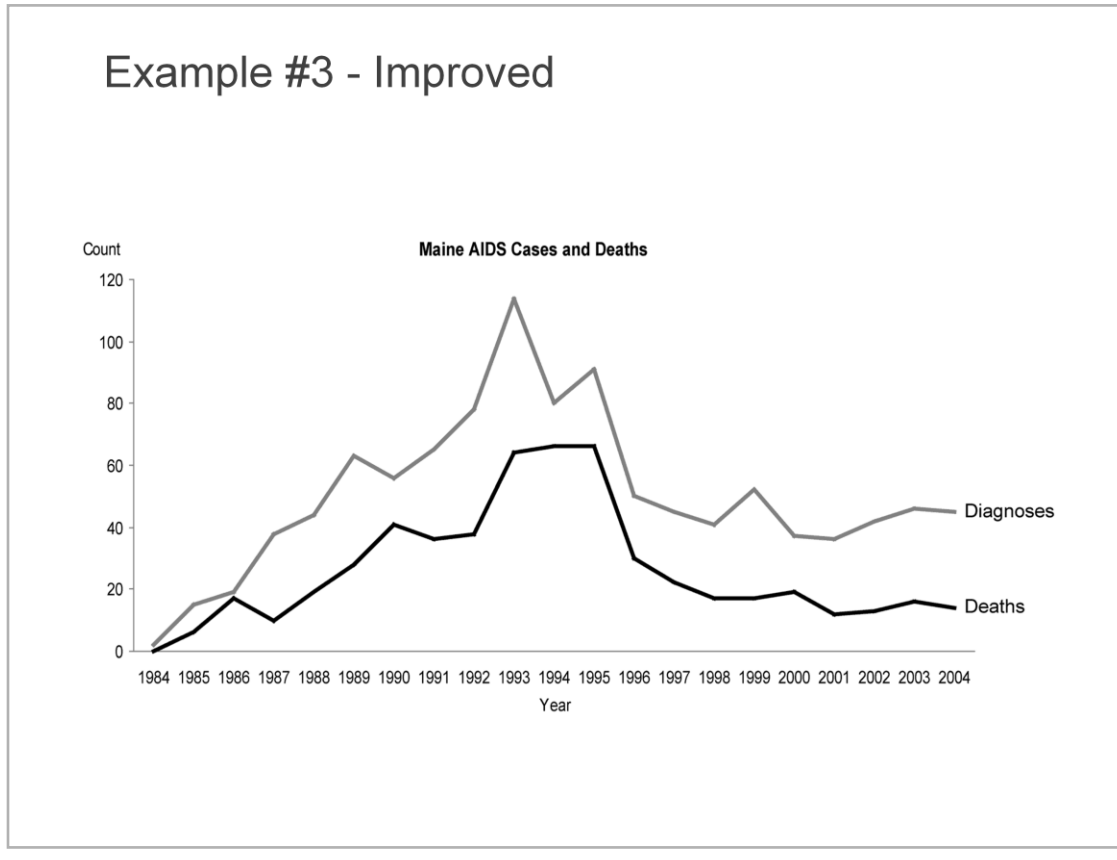

But in this graph there is no clutter and the patterns are crystal clear and easy to compare.

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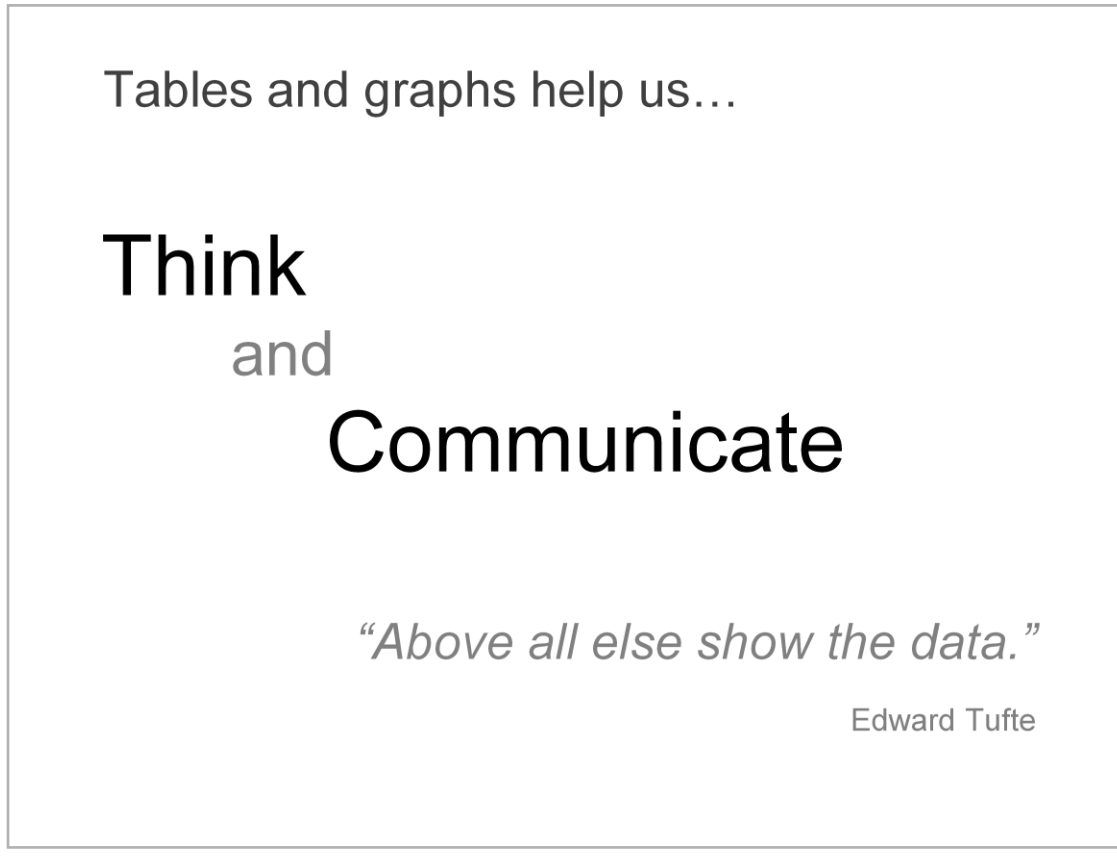

This Edward R. Tufte quote is from his milestone work, *The Visual Display of Quantitative Information*, published by Graphics Press in 1983.

In tables and graphs:

- The message is in the data.
- The medium of communication, especially for graphs, is visual.
- To communicate the data effectively, you must understand visual perception – what works, what doesn’t, and why.

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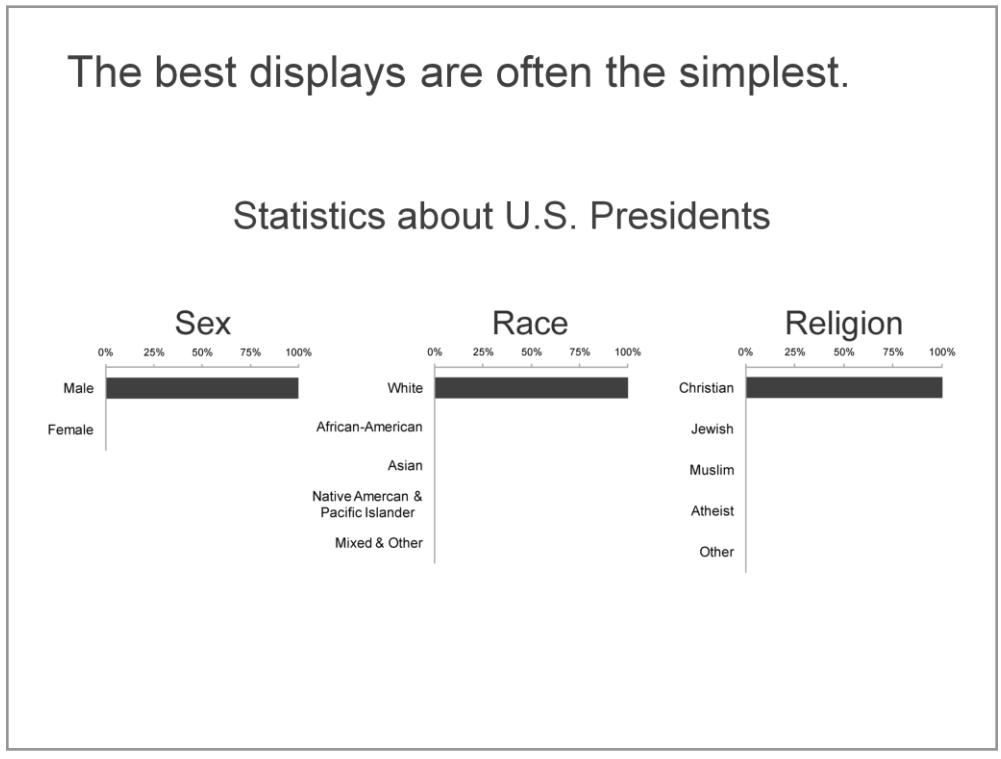

Often, the simplest form of display is the most powerful.

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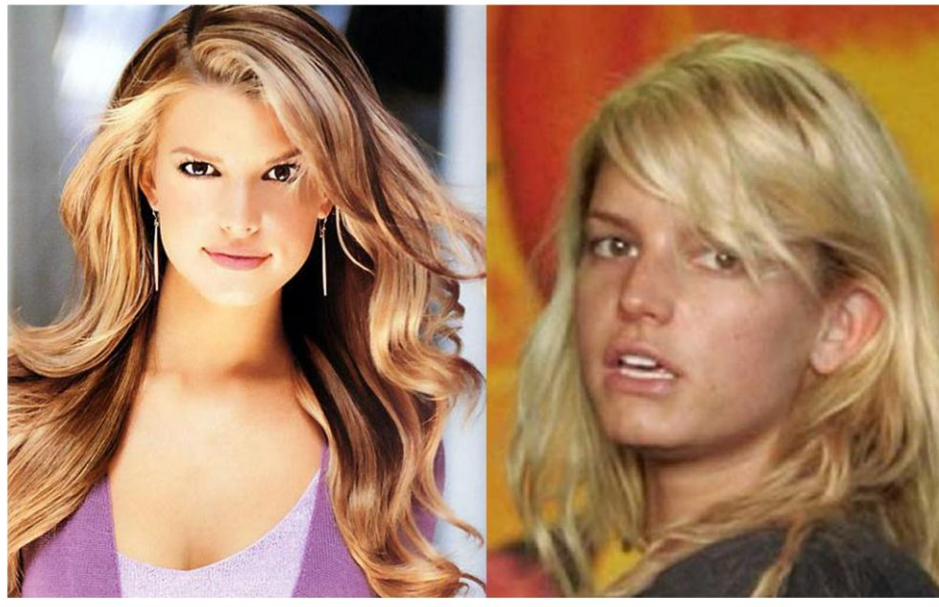
Which would you rather look at?



What if you are Jessica's dermatologist?

Dressing things up is appropriate for advertising, because the illusion pleases and sells. When you're responsible for discovering the truth and understanding it, however, makeup only gets in the way.

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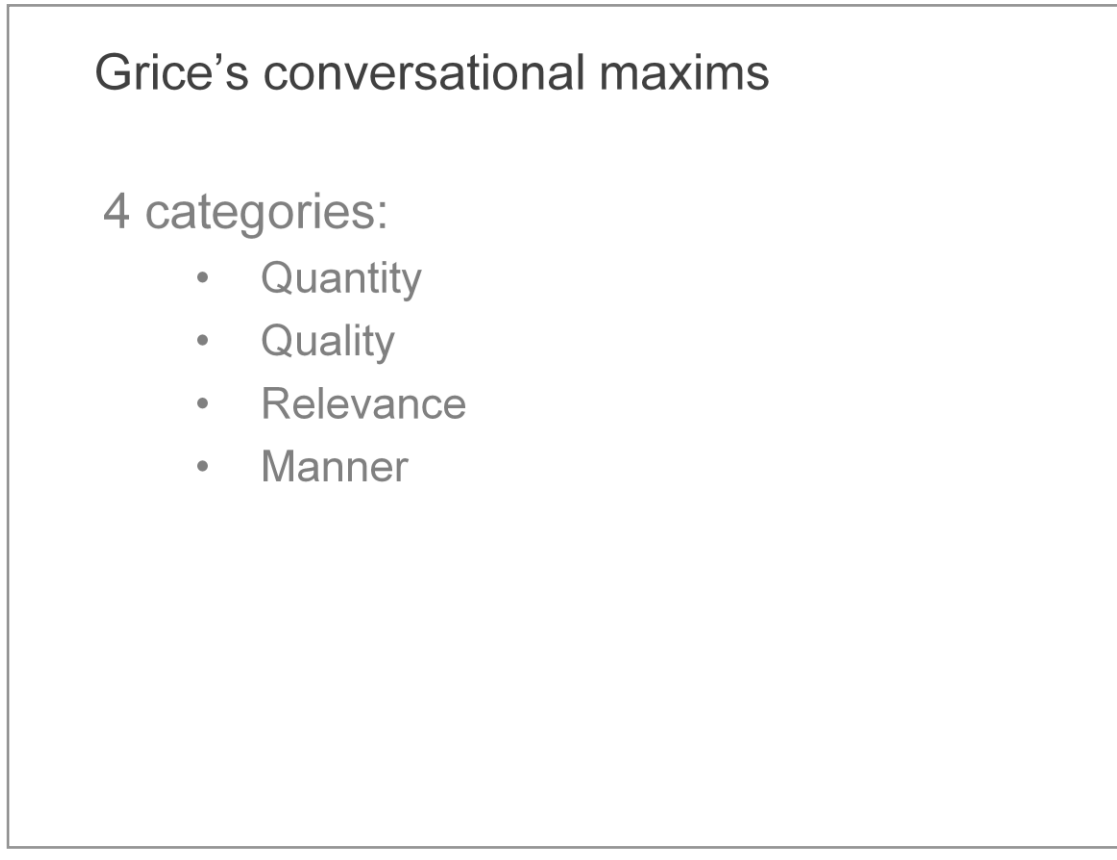

Paul Grice was a 20th century philosopher whose work ventured into the realm of linguistics. He is well known for his conversational maxims, which attempt the describe the characteristics of polite conversation.

Every one of these maxims of conversation apply equally well to the communication of quantitative information in the workplace. We'll strive in this workshop to translate these maxims into effective and polite communication via tables and graphs.

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Grice's conversational maxims: Quantity

1. Make your contribution to the conversation as informative as necessary.
2. Do not make your contribution to the conversation more informative than necessary.

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Grice's conversational maxims: Quality

1. Do not say what you believe to be false.
2. Do not say that for which you lack adequate evidence.

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Grice's conversational maxims: Relevance

Be relevant (that is, say things related to the current topic of conversation).

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Grice's conversational maxims: Manner

1. Avoid obscurity of expression.
2. Avoid ambiguity.
3. Be brief (avoid unnecessary wordiness).
4. Be orderly.

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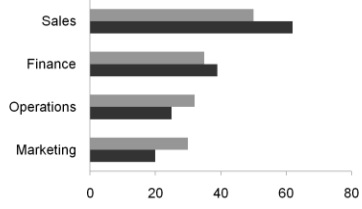
Fundamental challenges of data presentation

1. Determining the medium that tells the story best

Either

Product	Units Sold	Revenue
Food	34,837	746,383
Beverage	42,374	845,984
Total	77,211	1,592,367

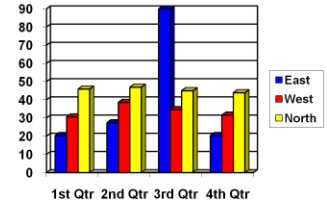
or



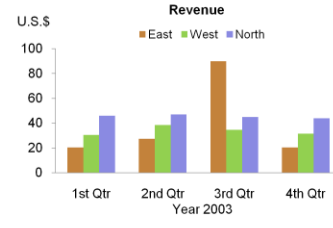
and which kind?

2. Designing the visual components to tell the story clearly

From



to



1. You begin by determining the best medium for your data and the message you wish to emphasize. Does it require a table or a graph? Which kind of table or graph?
2. Once you've decided, you must then design the individual components of that display to present the data and your message as clearly and efficiently as possible.

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Tables work best when…

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1990	127.4	128.0	128.7	128.9	129.2	129.9	130.4	131.6	132.7	133.5	133.8	133.8	130.7
1991	134.6	134.8	135.0	135.2	135.6	136.0	136.2	136.6	137.2	137.4	137.8	137.9	136.2
1992	138.1	138.6	139.3	139.5	139.7	140.2	140.5	140.9	141.3	141.8	142.0	141.9	140.3
1993	142.6	143.1	143.6	144.0	144.2	144.4	144.4	144.8	145.1	145.7	145.8	145.8	144.5
1994	146.2	146.7	147.2	147.4	147.5	148.0	148.4	149.0	149.4	149.5	149.7	149.7	148.2
1995	150.3	150.9	151.4	151.9	152.2	152.5	152.5	152.9	153.2	153.7	153.6	153.5	152.4
1996	154.4	154.9	155.7	156.3	156.6	156.7	157.0	157.3	157.8	158.3	158.6	158.6	156.9
1997	159.1	159.6	160.0	160.2	160.1	160.3	160.5	160.8	161.2	161.6	161.5	161.3	160.5
1998	161.6	161.9	162.2	162.5	162.8	163.0	163.2	163.4	163.6	164.0	164.0	163.9	163.0
1999	164.3	164.5	165.0	166.2	166.2	166.2	166.7	167.1	167.9	168.2	168.3	168.3	166.6
2000	168.8	169.8	171.2	171.3	171.5	172.4	172.8	172.8	173.7	174.0	174.1	174.0	172.2
2001	175.1	175.8	176.2	176.9	177.7	178.0	177.5	177.5	178.3	177.7	177.4	176.7	177.1
2002	177.1	177.8	178.8	179.8	179.8	179.9	180.1	180.7	181.0	181.3	181.3	180.9	179.9

- Used to look up individual values
- Data must be precise

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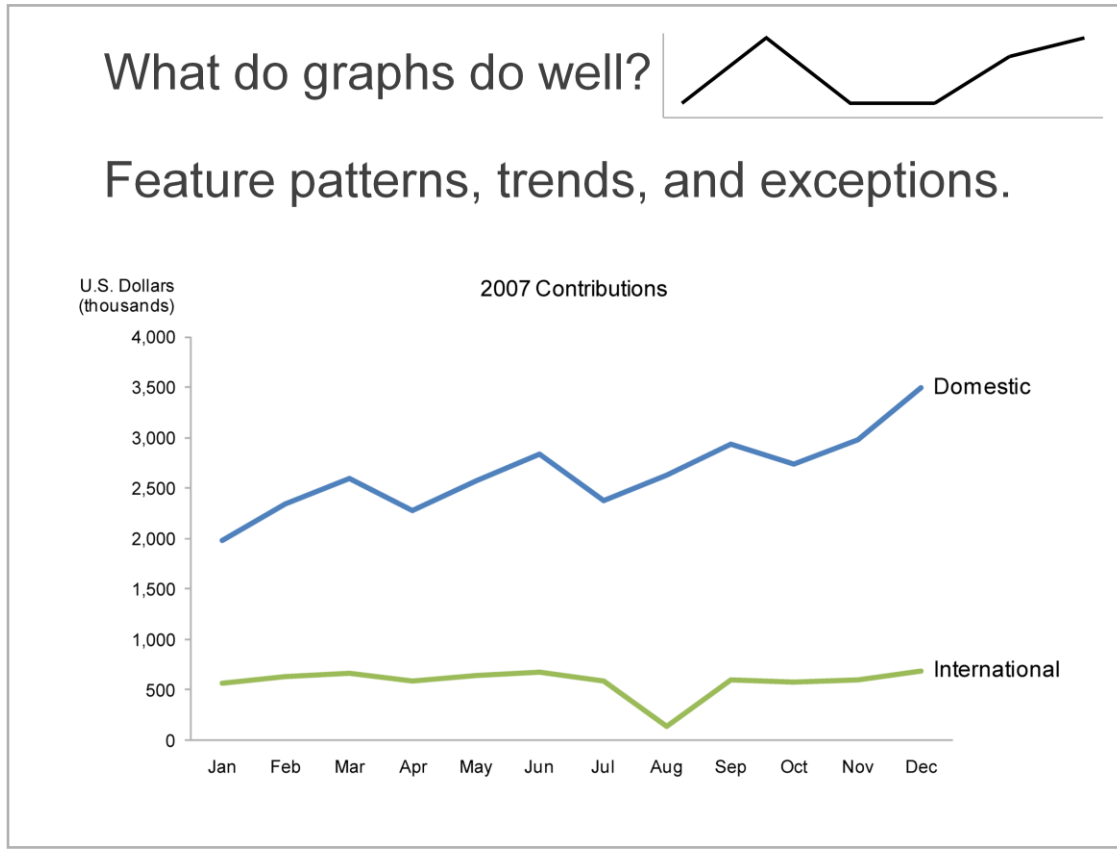

The saying, “A picture is worth a thousand words,” applies quite literally to quantitative graphs. By displaying quantitative information in visual form, graphs efficiently reveal information that would otherwise require a thousand words or more to adequately describe.

In this example of purely manufactured data to illustrate my point…

Joseph Berkson once stated what happens quite powerfully: When we visualize the data effectively and suddenly, we experience “interocular traumatic impact”—a conclusion that hits us between the eyes.

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Can you see trends, patterns and exceptions in this table of numbers?

Data table for figure 1. Total population and older population: United States, 1950–2050

Year	*All ages*	*65 years and over*	*75 years and over*
		Number	
1950	150,216,110	12,256,850	3,852,395
1960	179,325,657	16,207,237	5,359,338
1970	203,211,926	20,065,502	7,630,046
1980	226,545,805	25,549,427	9,968,822
1990	248,709,873	31,078,895	13,033,400
2000	281,421,906	34,991,753	16,600,767
2004	293,622,764	36,221,951	17,777,261
2010	308,935,581	40,243,713	18,974,204
2020	335,804,546	54,631,891	22,852,732
2030	363,584,435	71,453,471	33,505,538
2040	391,945,658	80,049,634	44,579,726
2050	419,853,587	86,705,637	48,763,200

Tables work great for looking up individual values, but they don’t reveal trends, patterns, and exceptions very well.

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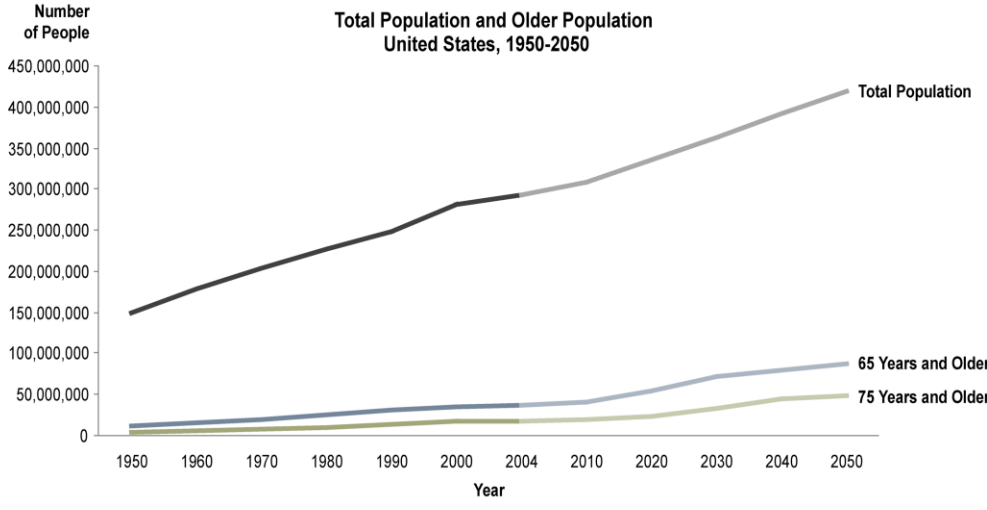
Graphs make trends, patterns and exceptions visible.



Now, however, by expressing this same information visually, giving shape to the data, the trends come alive.

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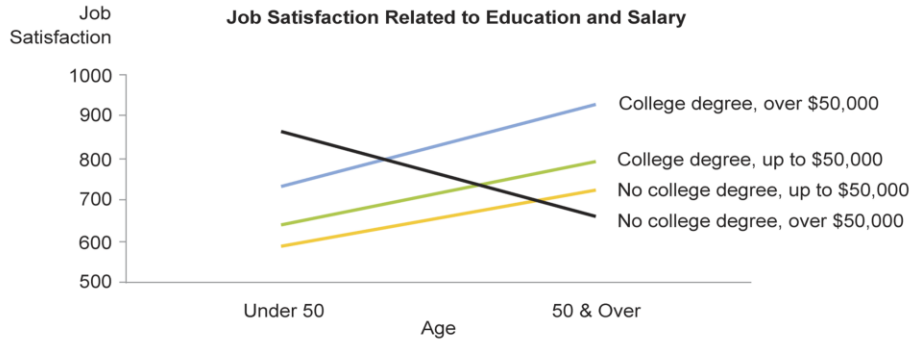
Even small data sets can benefit from graphs.

What's the message?

Job Satisfaction By Income, Education & Age

	College Degrees		No College Degrees	
Income	Under 50	50 & over	Under 50	50 & over
Up to $50,000	643	793	590	724
Over $50,000	735	928	863	662



The fact that job satisfaction for employees without a college degree decreases significantly in their later years doesn't jump out at you when you examine the table, but it is immediately obvious when you examine the graph.

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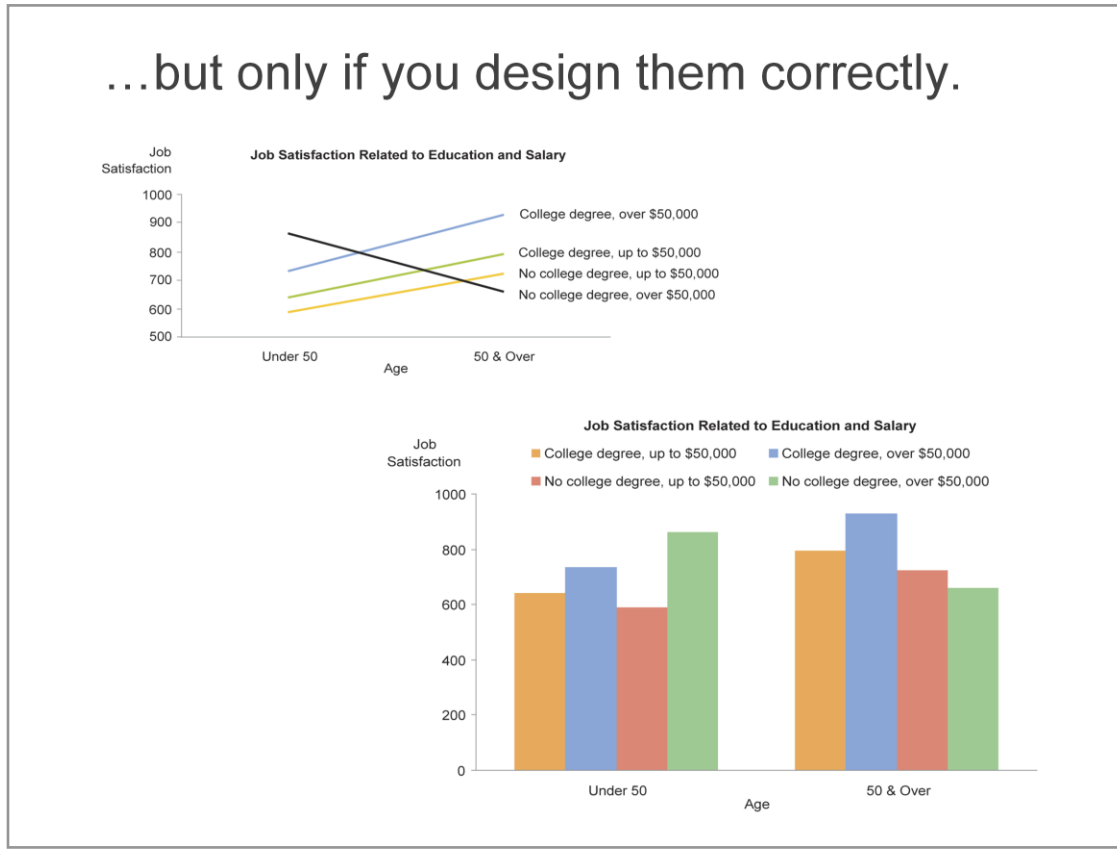

The type of graph that is selected and the way it's designed also have great impact on the message that is communicated. By simply switching from a line graph to a bar graph, the decrease in job satisfaction among those without college degrees in their later years is no longer as obvious.

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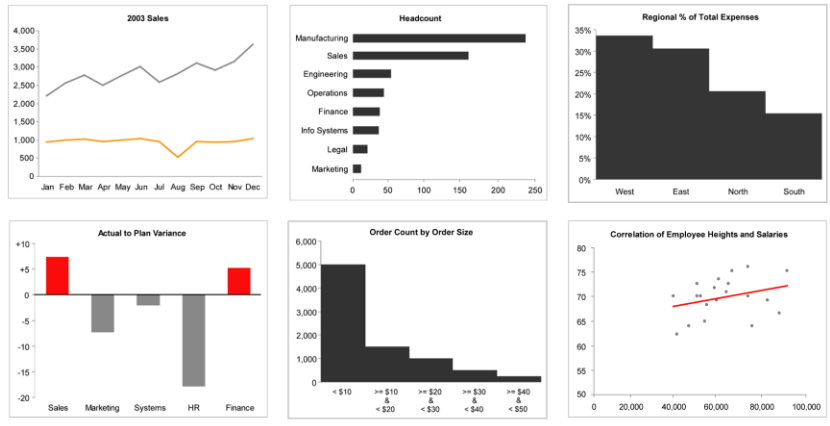
Quantitative messages always feature relationships.



Each of these graphs illustrates a different type of quantitative relationship. Just as in life in general, the interesting and important content of a graph always involves relationships.

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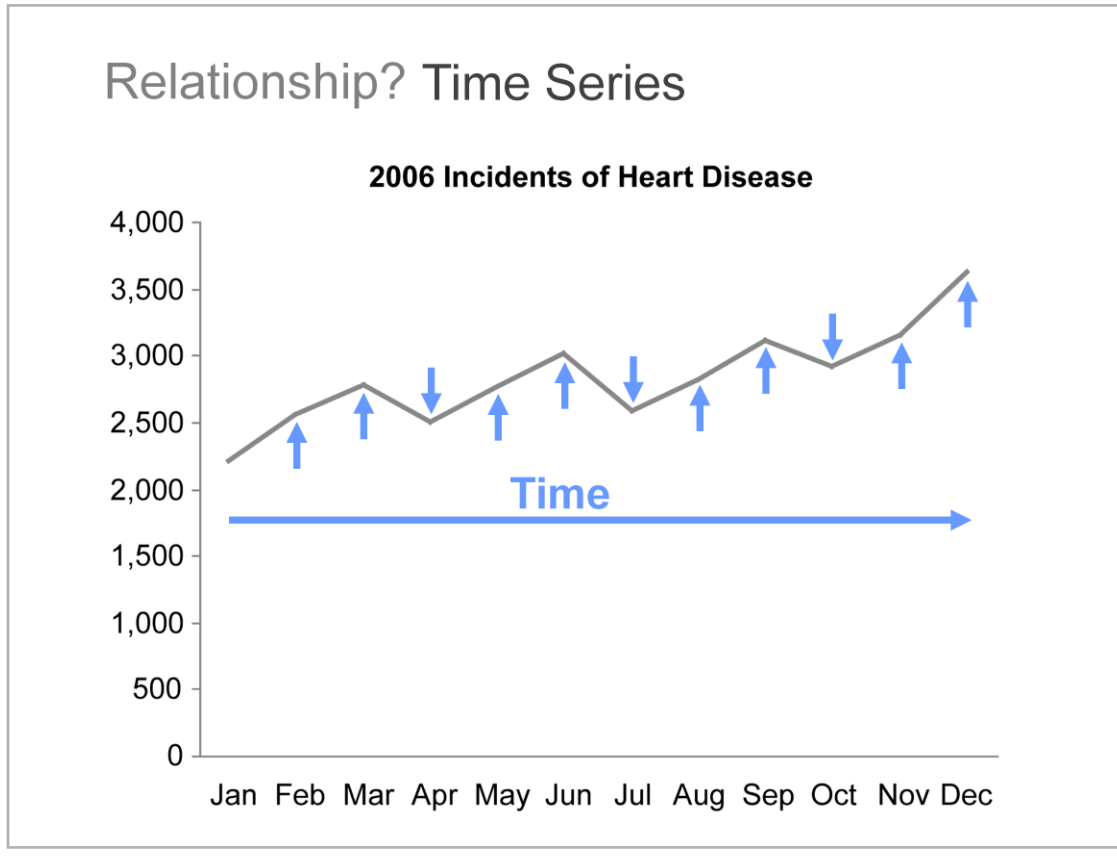

This graph features the relationships between values as they change through time, which is perhaps the most common quantitative relationship that you need to communicate.

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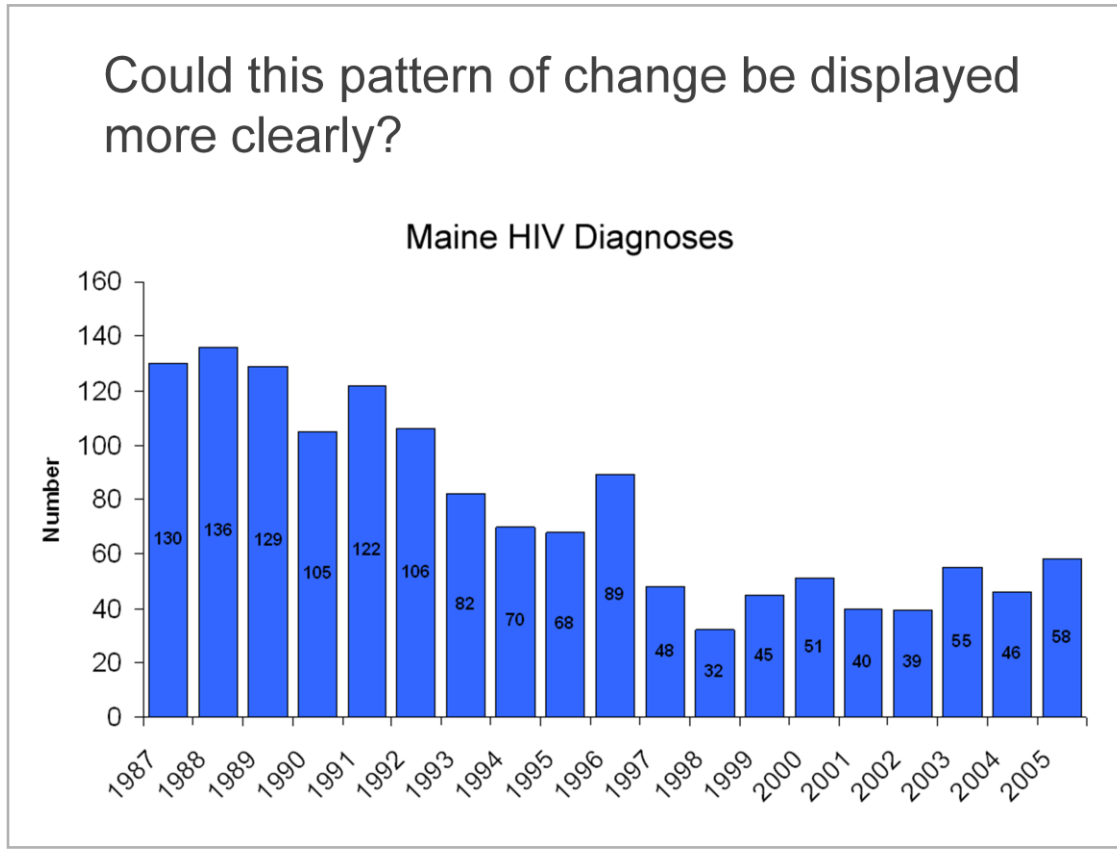

Here's an attempt to display a time-series relationship regarding HIV diagnoses, which works fairly well, but the trend and patterns could be much more clearly displayed.

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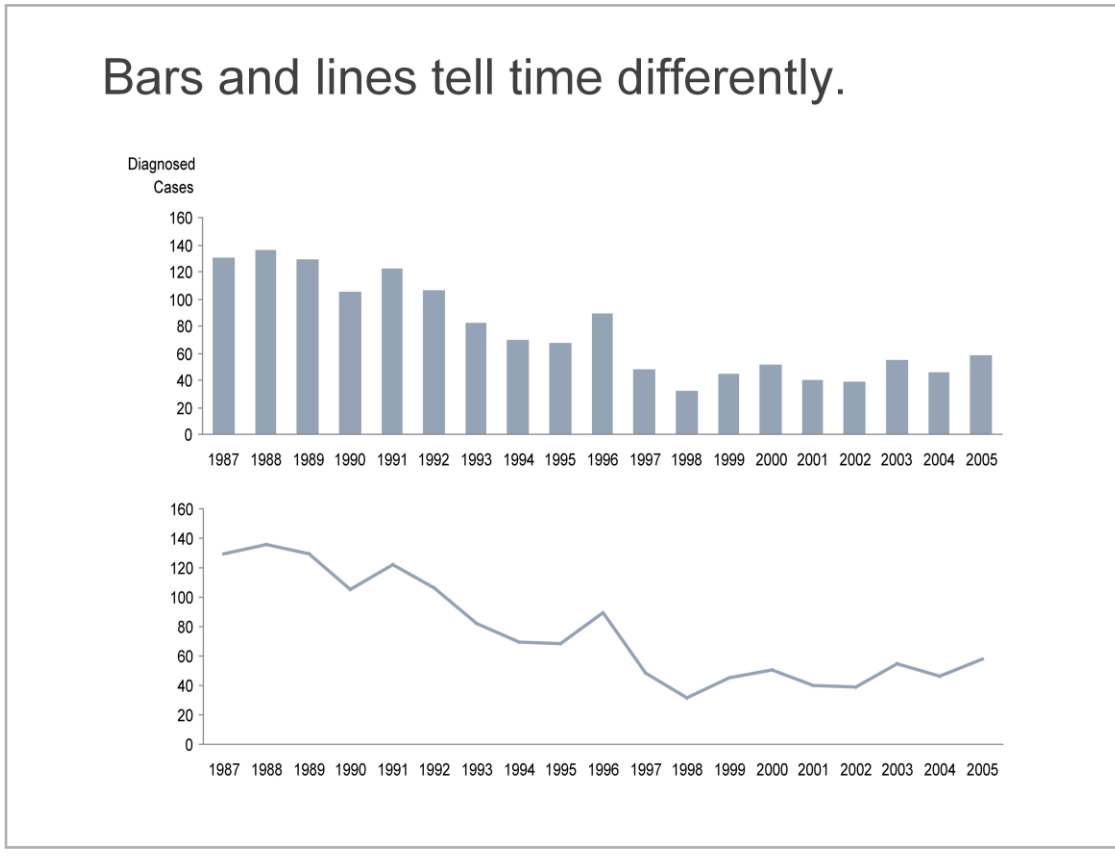

Here's the same exact data presented in two ways: to top graph uses bars and the bottom graph uses a line. Which displays the shape of change through time more clearly?

Bars work well for comparing individual values to one another, but lines show the shape of change through time much more clearly.

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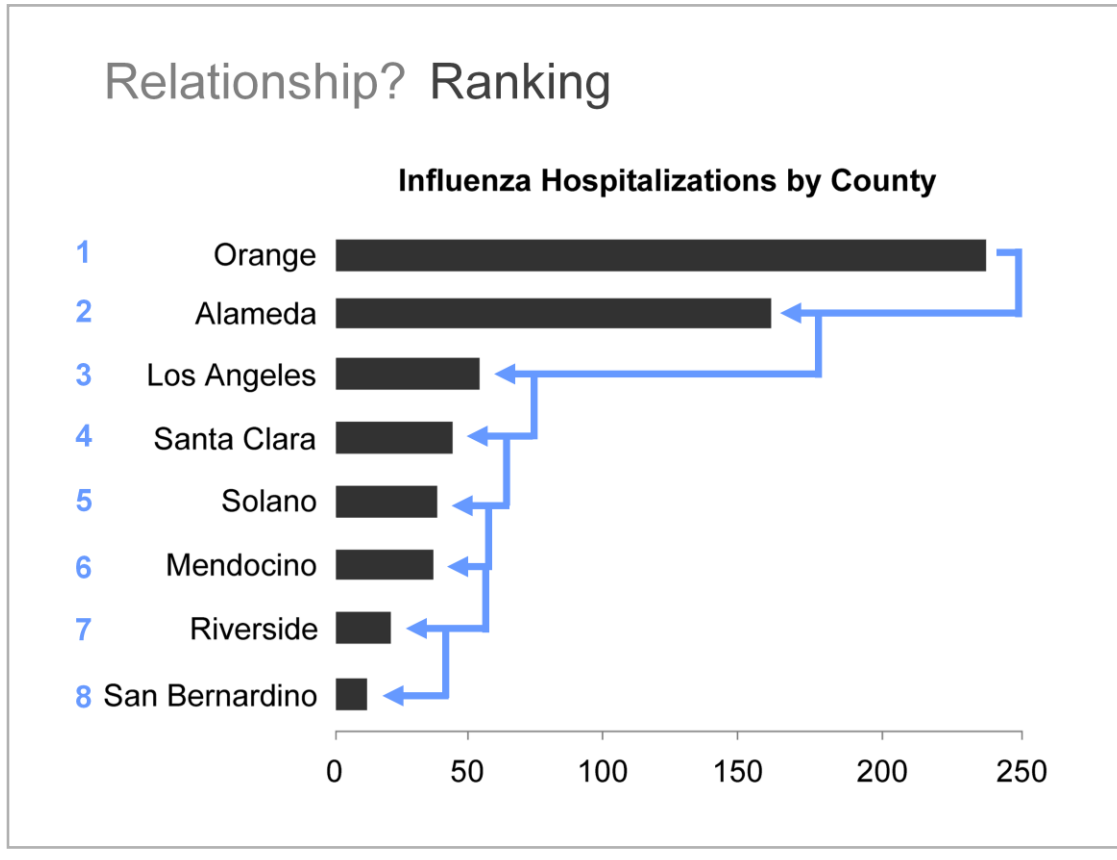

We've been talking about time-series relationships, but this graph features a different relationship between the values. The values are arranged in order of size, in this case from big to small. Arranging values sequentially makes them easier to compare to one another and directly communicates the relationship of rank.

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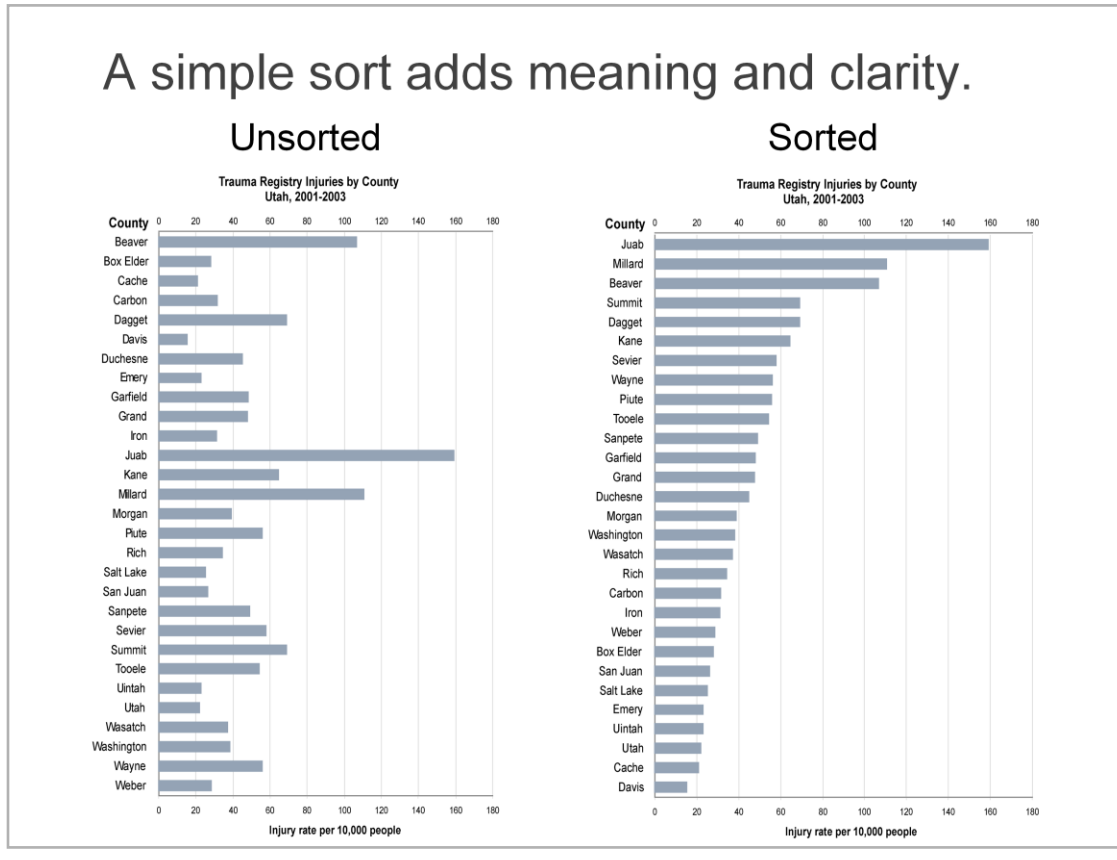

In the display of trauma registry injuries by county on the left, notice how difficult it is to compare the values and to get a sense of rank when they aren't sequenced by size.

The same information is displayed on the right, this time with the counties arranged by the number of injuries. If the purpose of the display is to look up individual values, which is the only thing that alphabetical order supports, a table would work much better. The ranking display on the right, however, tells a useful story.

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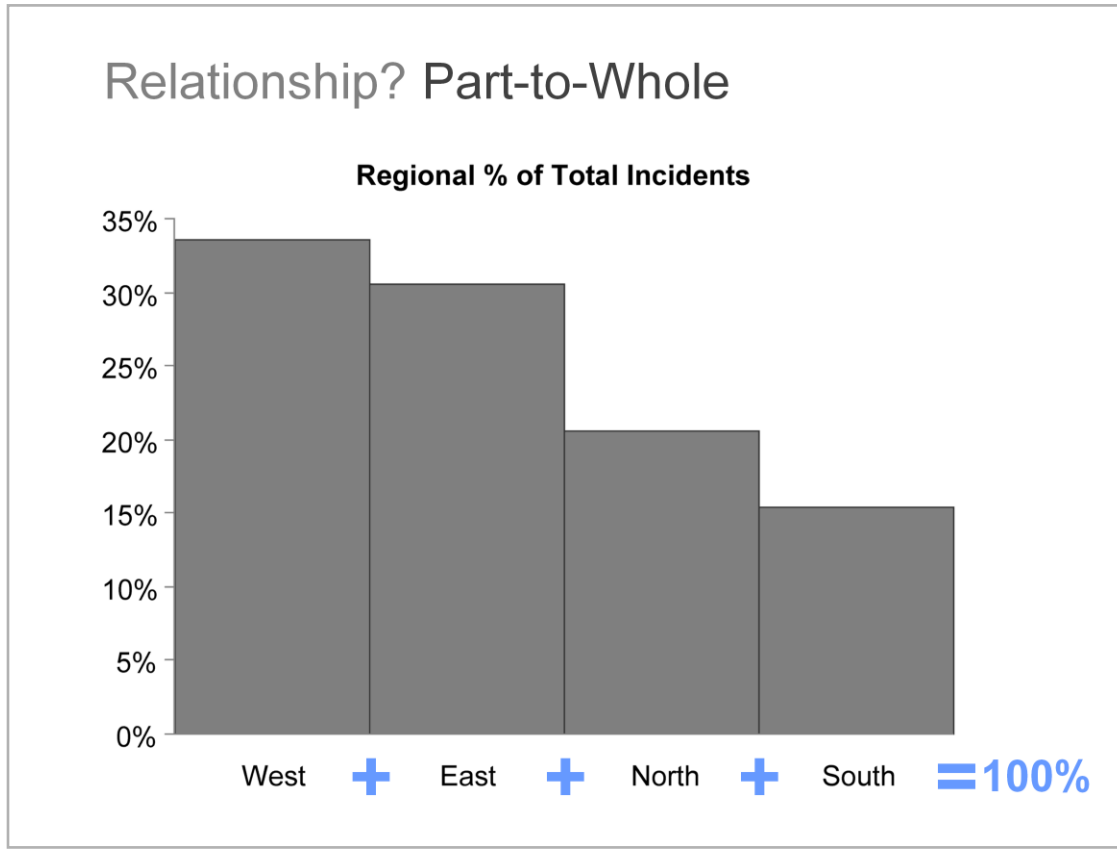

This graph features another relationship that is commonly displayed. Notice that if you add the values they total 100%. This is what I call a part-to-whole relationship, which shows how the individual values that make up some whole relate to one another and to the whole.

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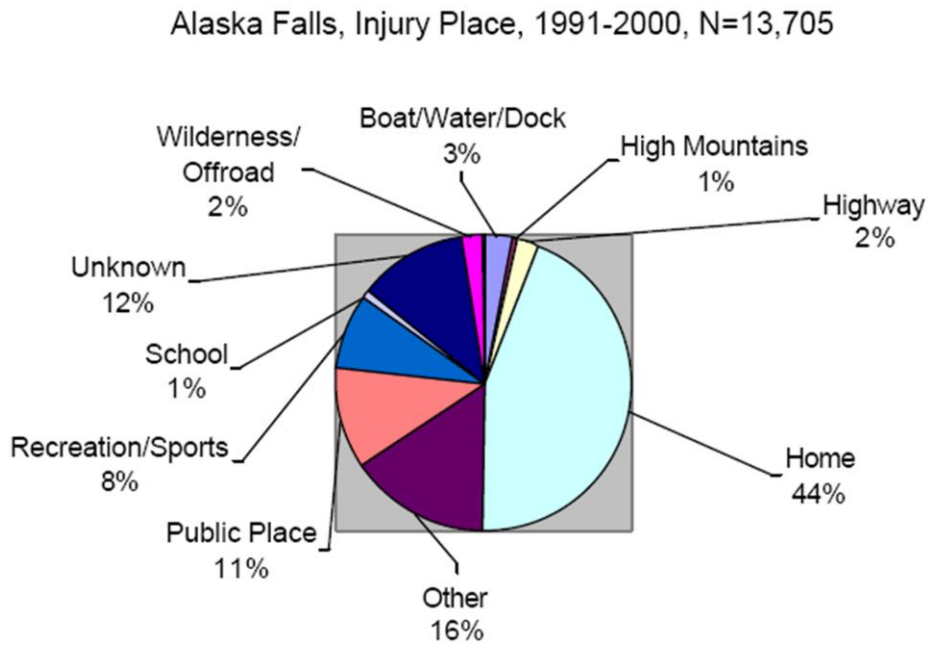
Pie charts are difficult to read.



Part-to-whole relationships are typically displayed as pie charts, but they don't communicate very effectively. If you want to see the order of items and to compare the size of one to another, with this display you would struggle,…

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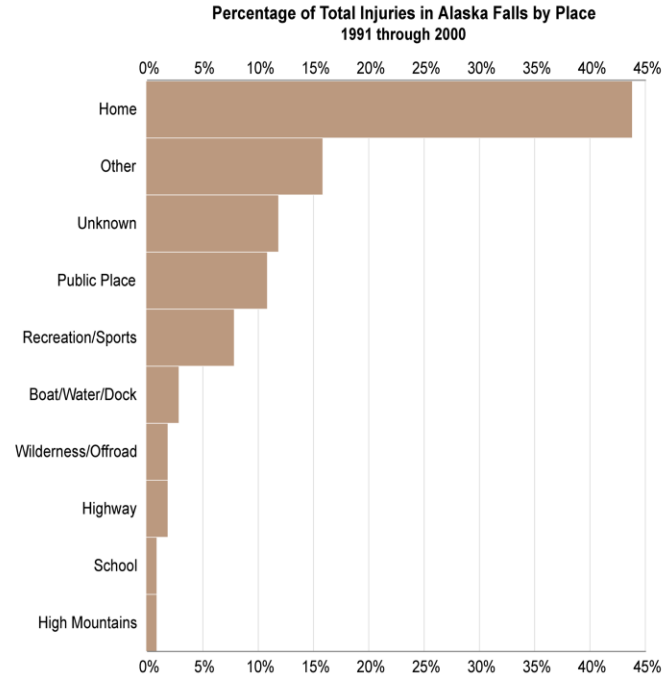
A bar graph tells this story clearly.



…but with this bar graph the story simply—nothing fancy, but clear.

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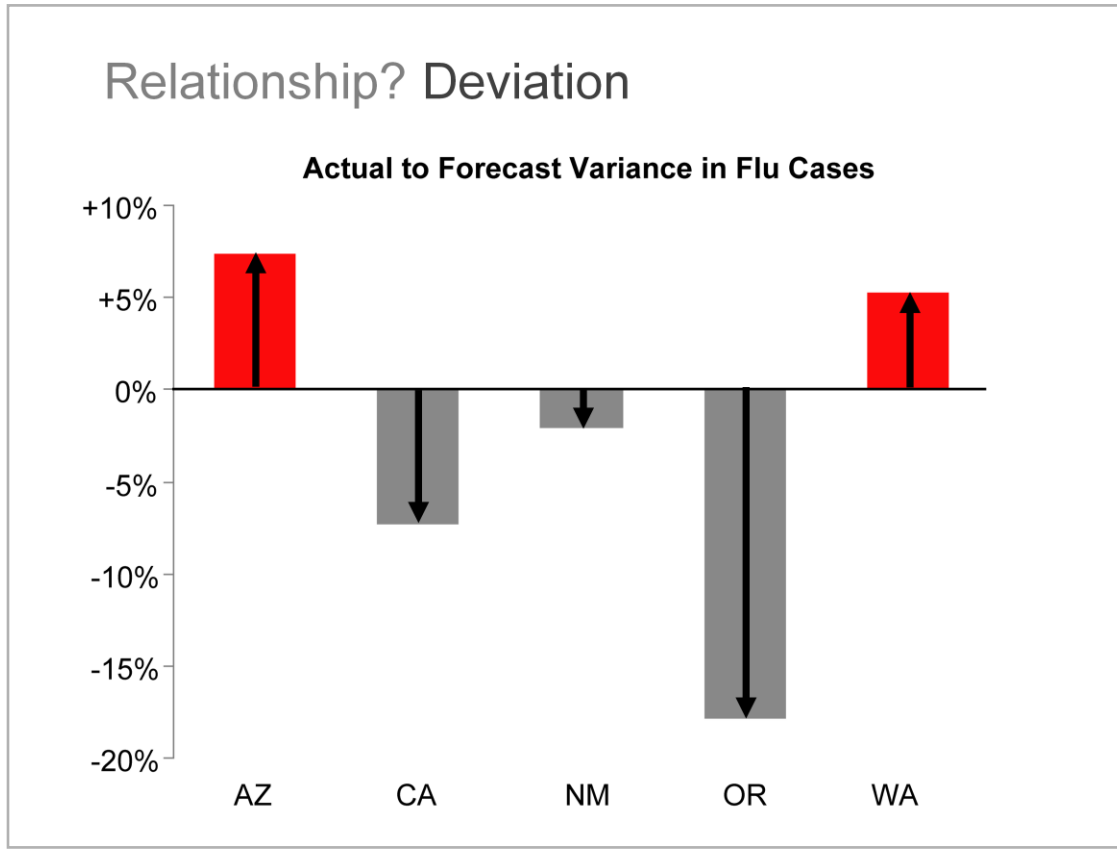

This graph features the next common relationship between values. This approach is used when you want to feature how one set of values differs from another reference set of values. I call this a deviation relationship.

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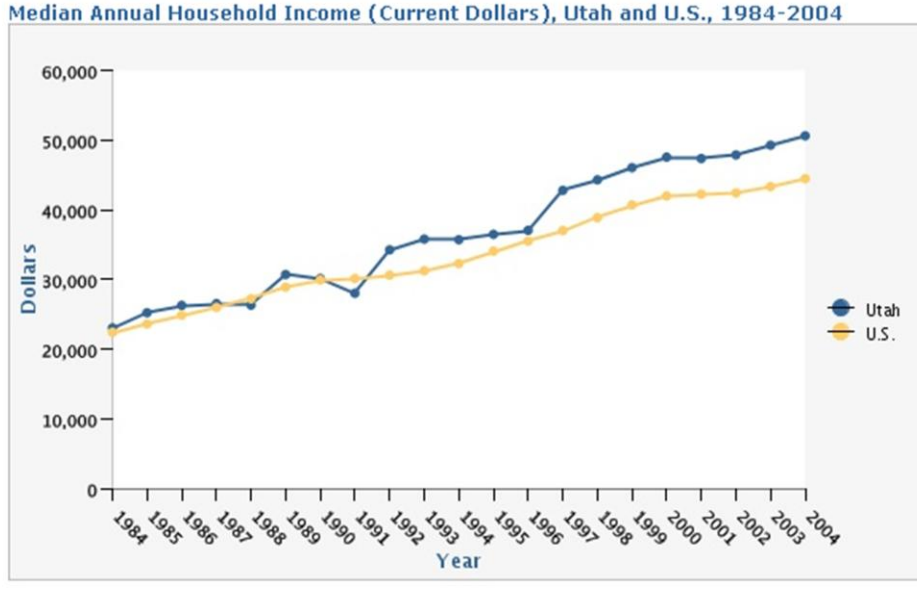
Don’t force people to calculate differences in their heads.



When people primarily need to see the differences between things, show them the difference directly, rather than showing them the two sets of values and forcing them to construct a new picture in their heads of how they differ.

The difference between the median annual household income in Utah and in the U.S. as a whole isn’t shown directly in this graph,…

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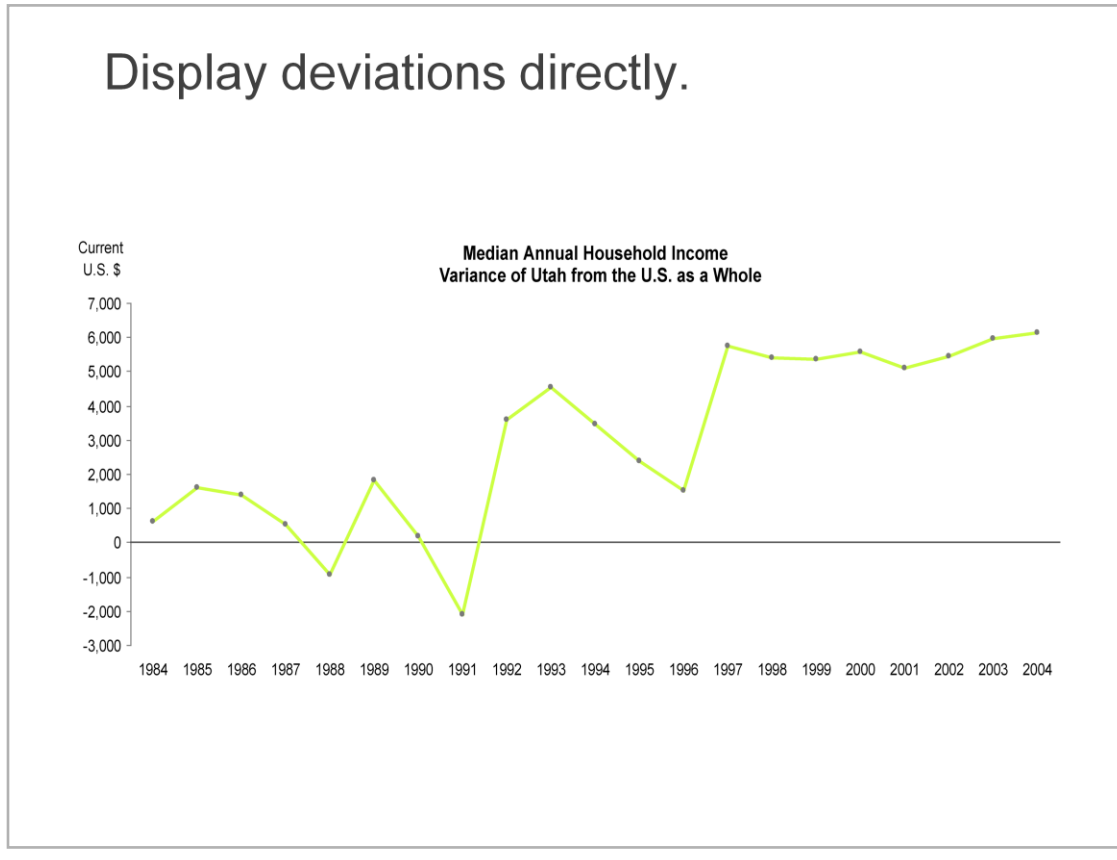

…but this graph directly expresses how household income in Utah has differed over time from the U.S. as a whole in positive and negative dollars.

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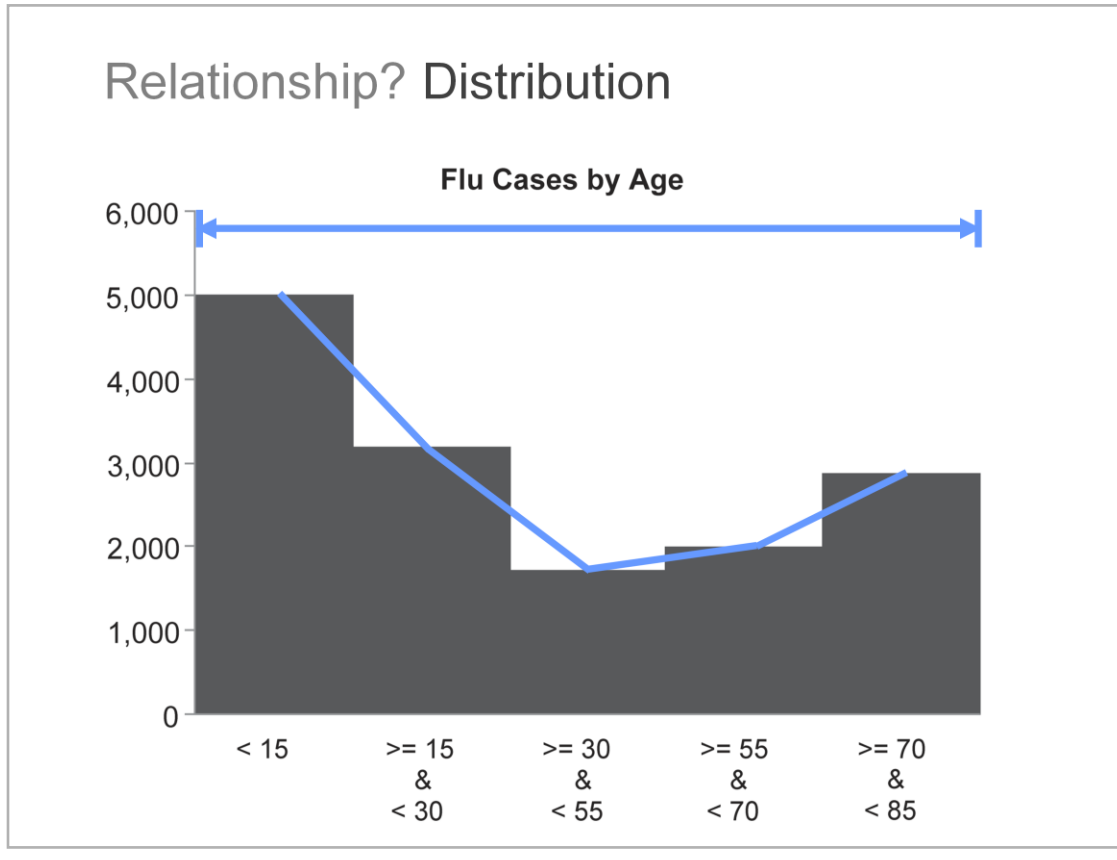

The relationship that this graph features the spread of a set of values from lowest to highest and the shape of their distribution across that range.

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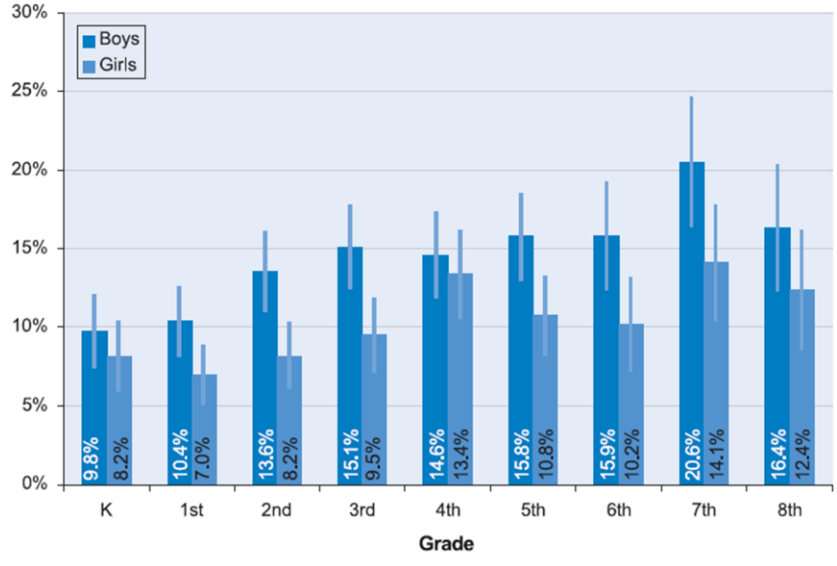
Histograms with multiple data sets can look cluttered.

Overweight* by Grade and Gender

Figure 1. Percentage of Utah children who were overweight by grade and gender, Utah, 2002



Here's a graph that attempts to show the distribution of overweight children by grade separately for boys and girls, but doing it in this way results in clutter that makes the patterns difficult to segregate and compare.

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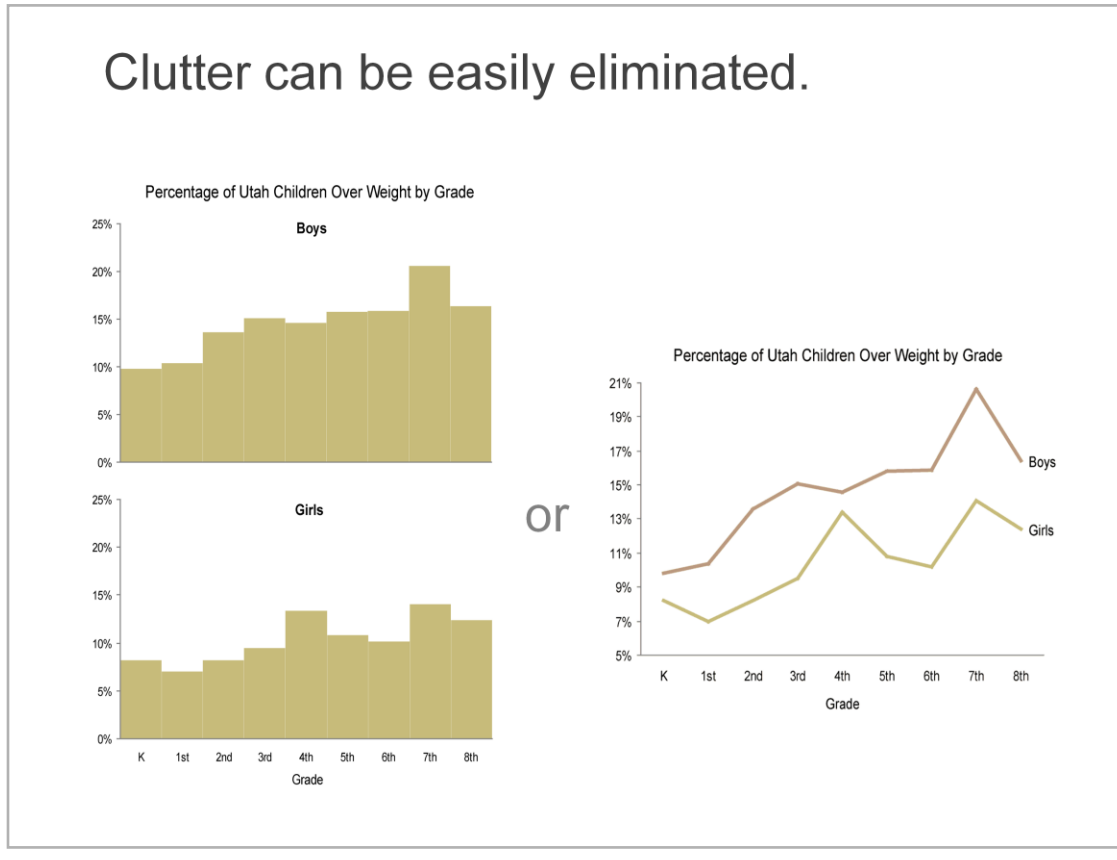

This pair of histograms—one for boys and one for girls—however, are arranged in a way that makes the patterns of each easy to see, yet still easy to compare.

Even better, by using lines rather than bars, the separate patterns can be shown in the same graph in a way that features the shape of the patterns and how they differ.

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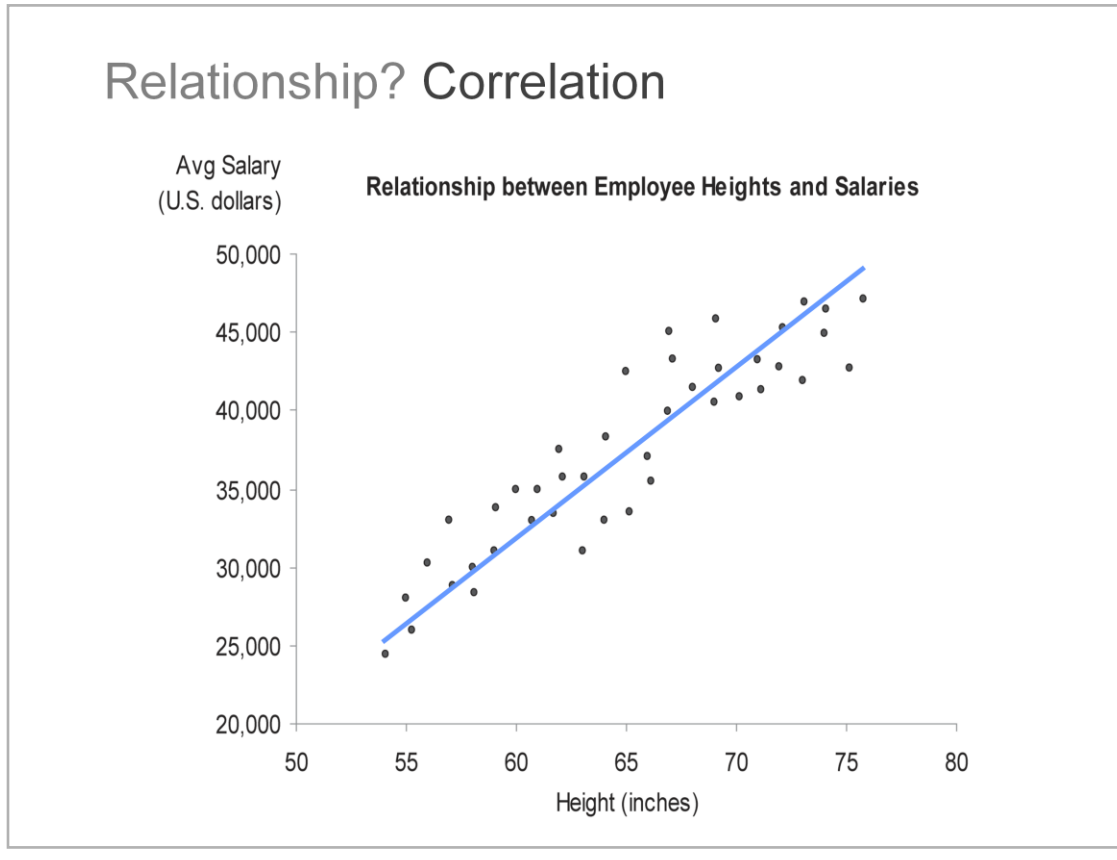

This graph illustrates the last of the six relationships. Graphs such as this feature co-relations between two paired sets of values, so this relationship is called a correlation.

Correlations show whether two paired sets of measures, such as these purely fictional sets of income vs. health coverage data vary in relation to one another, and if so, in which direction (positive or negative) and to what degree (strong or weak).

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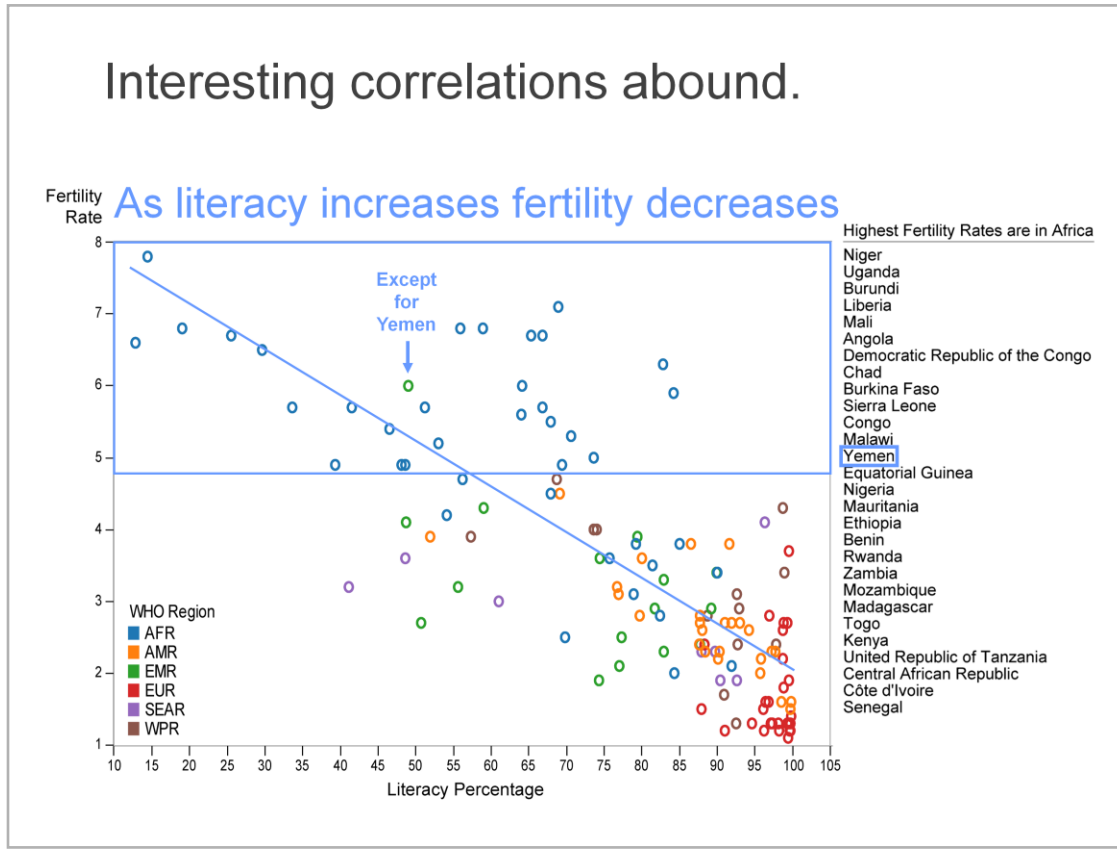

This example, based on WHO data, explores the correlation between adult literacy and fertility rate by country. A correlation clearly exists: higher literacy corresponds to lower rates of fertility. It is also clear from this display that the highest rates of fertility all occur in Africa (the blue circles), which the one exception of Yemen (the one green circle at the high end of fertility).

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Seven common relationships in graphs

- Time-series
- Ranking
- Part-to-whole
- Deviation
- Distribution
- Correlation

Without reviewing the last few slides, unless you must as a reminder, try to describe a real-world example of each type of relationship.

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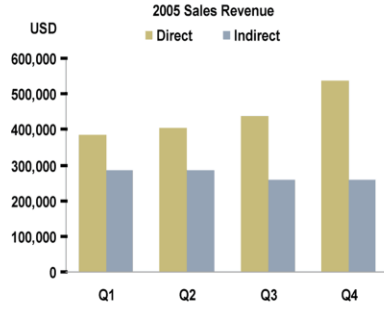
Data-Ink Ratio

Data Ink

2005 Sales Revenue (USD)

Sales Channel	Q1	Q2	Q3	Q4
Direct	383,383	403,939	437,373	538,583
Indirect	283,733	283,833	257,474	258,474
Total	667,116	687,772	694,847	797,057



Non-Data Ink

2005 Sales Revenue (USD)

Sales Channel	Q1	Q2	Q3	Q4
Direct	383,383	403,939	437,373	538,583
Indirect	283,733	283,833	257,474	258,474
Total	667,116	687,772	694,847	797,057

According to Edward Tufte, tables and graphs are made up of two types of ink: data ink and non-data ink. He introduced the concept of the “data-ink ratio” in his 1983 classic *The Visual Display of Quantitative Data*. He argued that the ratio of ink used to display data to the total ink should be high. In other words, ink that is used to display anything that isn’t data should be reduced to a minimum.

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Steps in the design process

1. Reduce the non-data ink.
   - Remove unnecessary non-data ink.
   - De-emphasize and regularize the remaining non-data ink.
2. Enhance the data ink.
   - Remove unnecessary data ink.
   - Emphasize the most important data ink.

"In anything at all, perfection is finally attained not when there is no longer anything to add, but when there is no longer anything to take away." Antoine de St. Exupery

John Maeda, in *The Laws of Simplicity*, offers a maxim about design simplicity, which I have massaged into the following statement:

> *Simplicity is about eliminating the obvious (and everything else that doesn't support your purpose), and enhancing the meaningful.*

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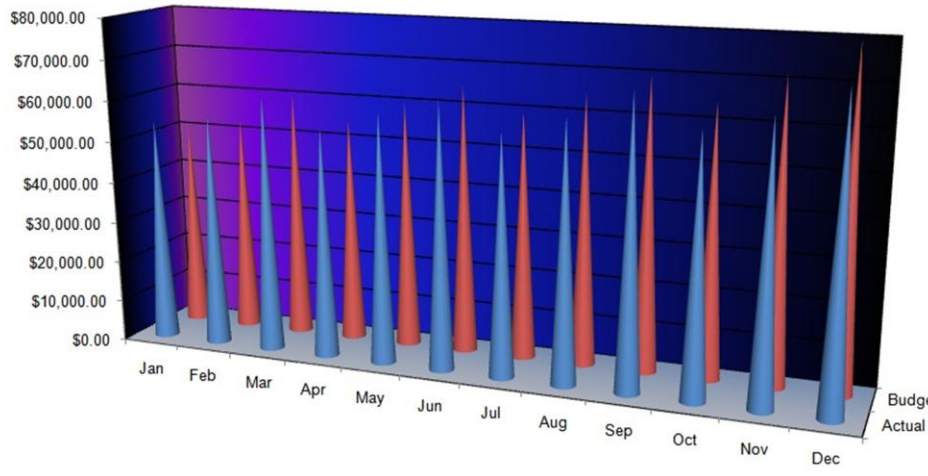
Poor graphs can be transformed.



This is the kind of graph that software products, including Excel, encourage us to create. They give us an infinite selection of poorly-designed graphs from which to choose. What we really need, however, is a small selection of graphs that really work.

Using this graph, try to see the pattern of change across the months in actual expenses. Try to determine one of the actual values. Try to compare actual expenses to the budget across time.

Let's transform this graph into one that communicates.

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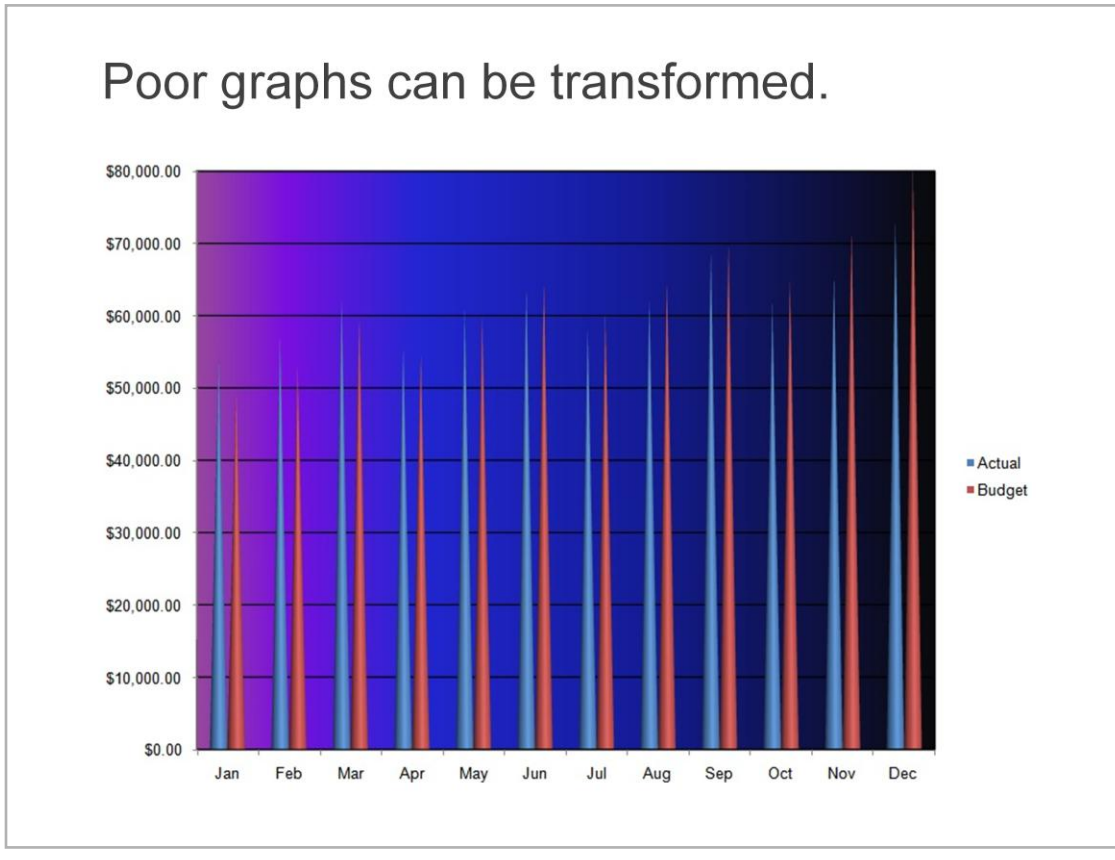

We have now removed the useless 3-D effects and angle, which makes the data easier to read.

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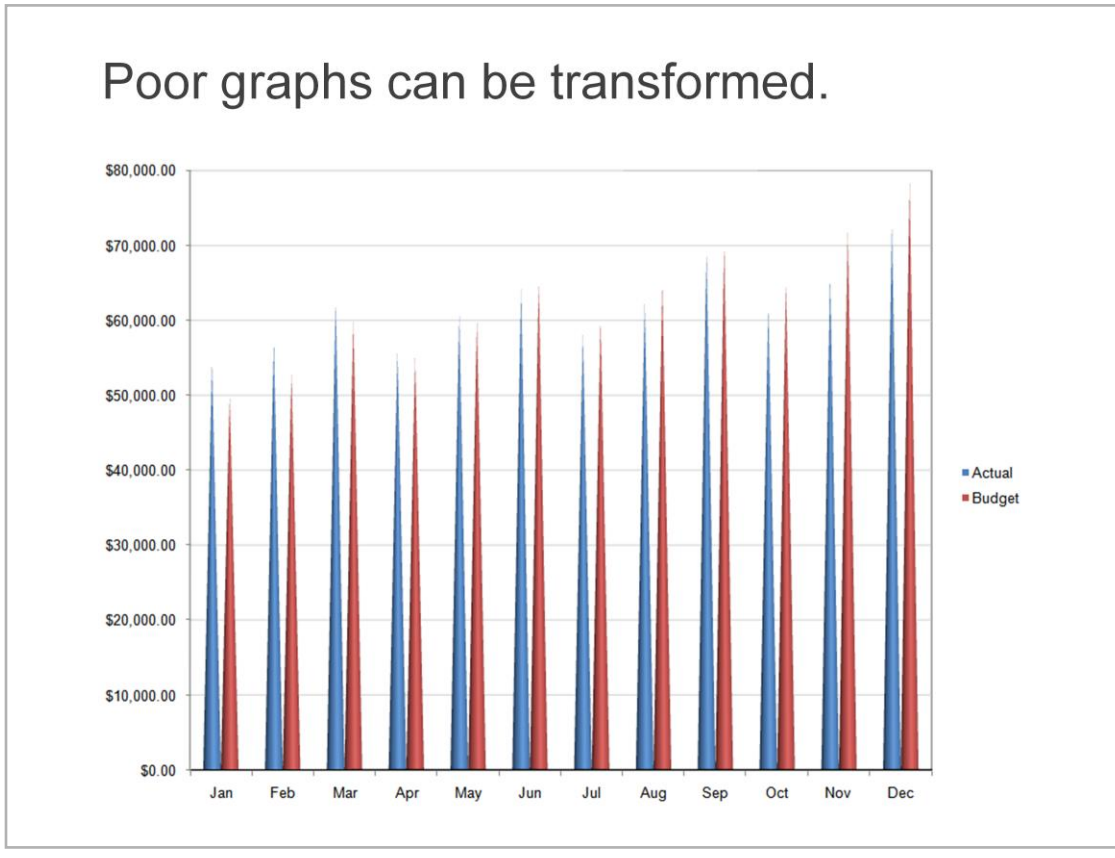

We have now removed the background fill color.

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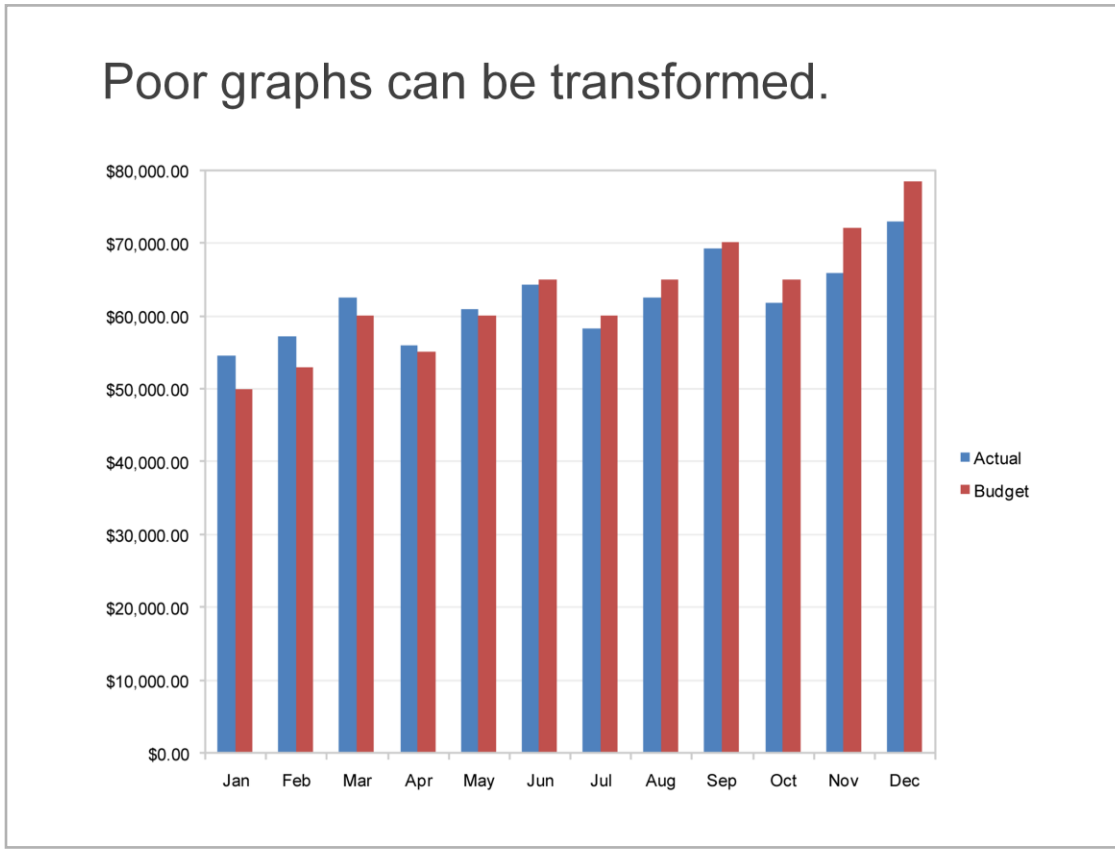

We have now replaced the silly cones with regular bars.

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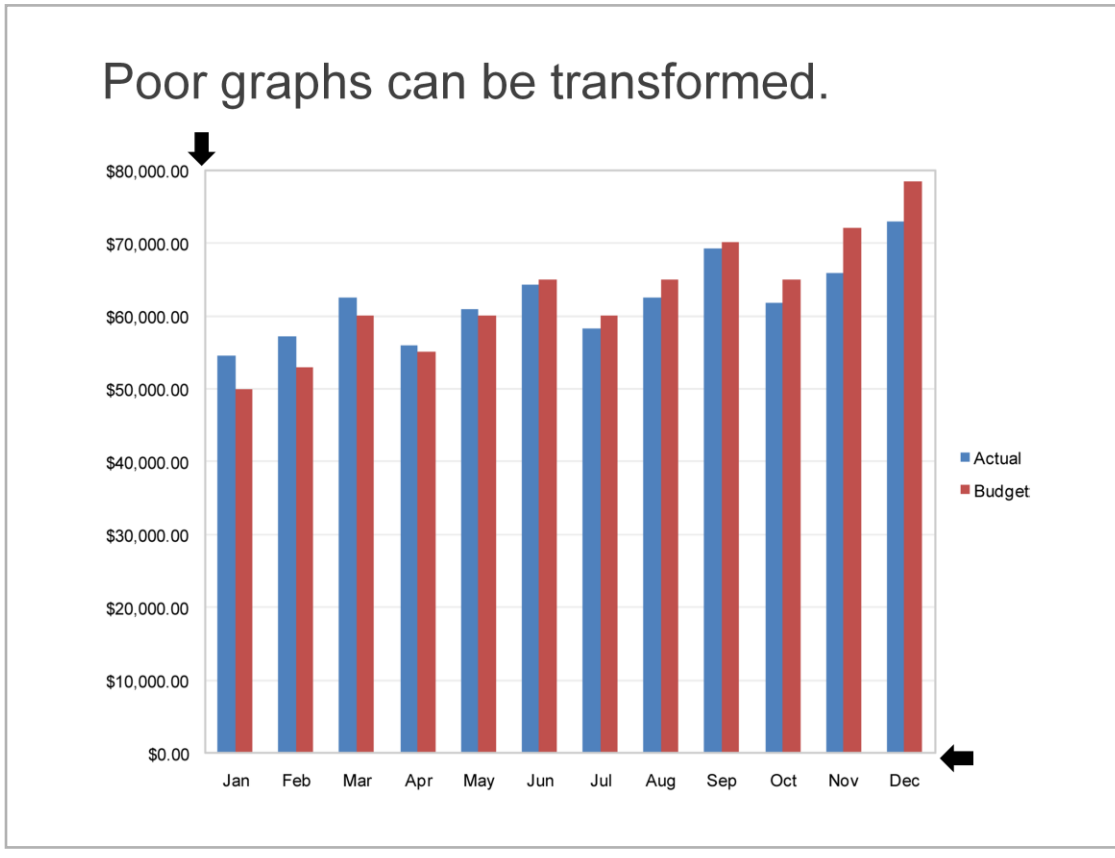

We have now removed the tick marks, which aren't necessary. Tick marks are not needed to separate the months along the X-axis and because horizontal grid lines are being displayed, there is no need for tick marks on the Y-axis either.

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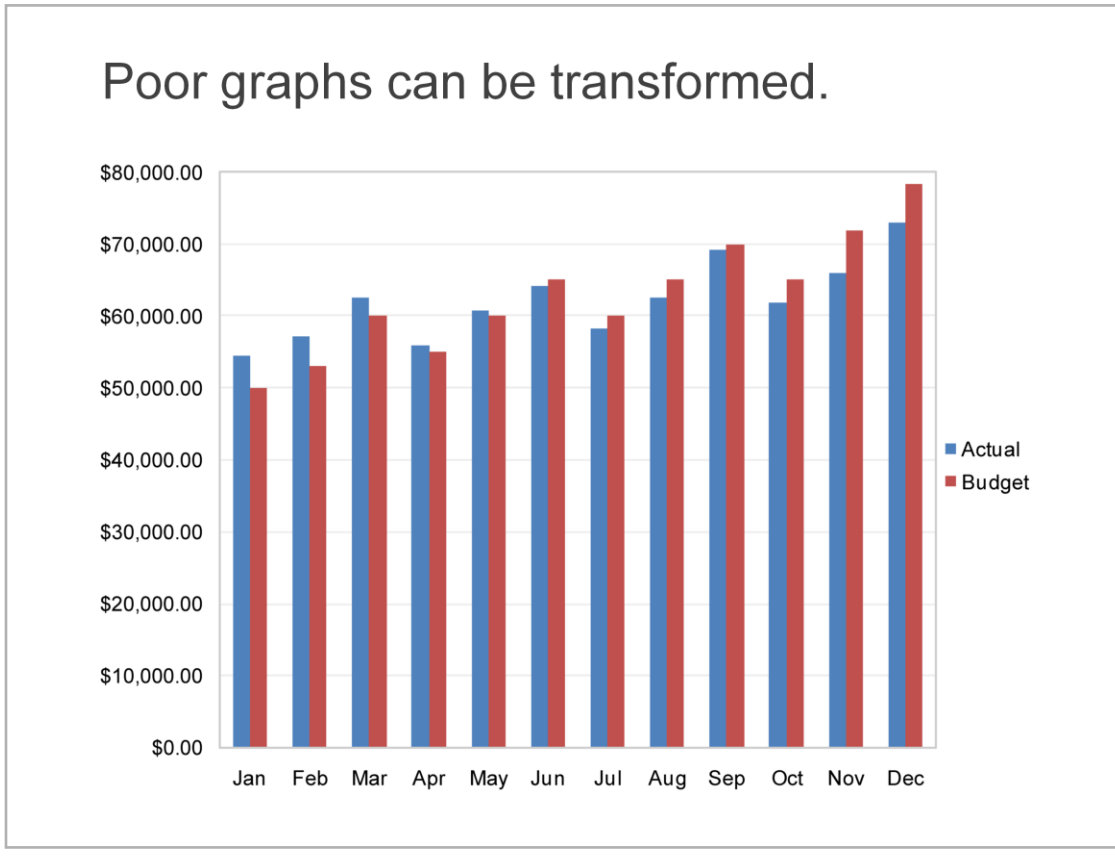

We have now enlarged the text, making it easier to read.

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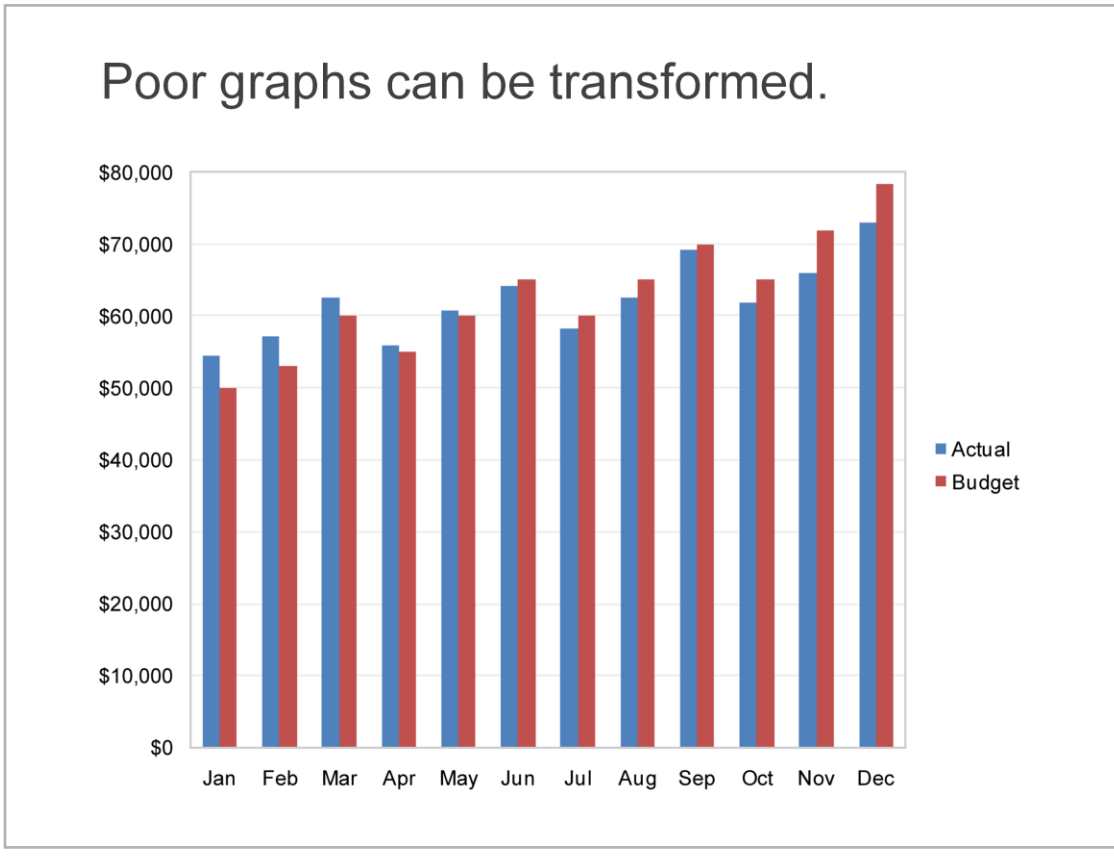

We have now removed the unnecessary decimal places in the dollar amounts along the Y-axis.

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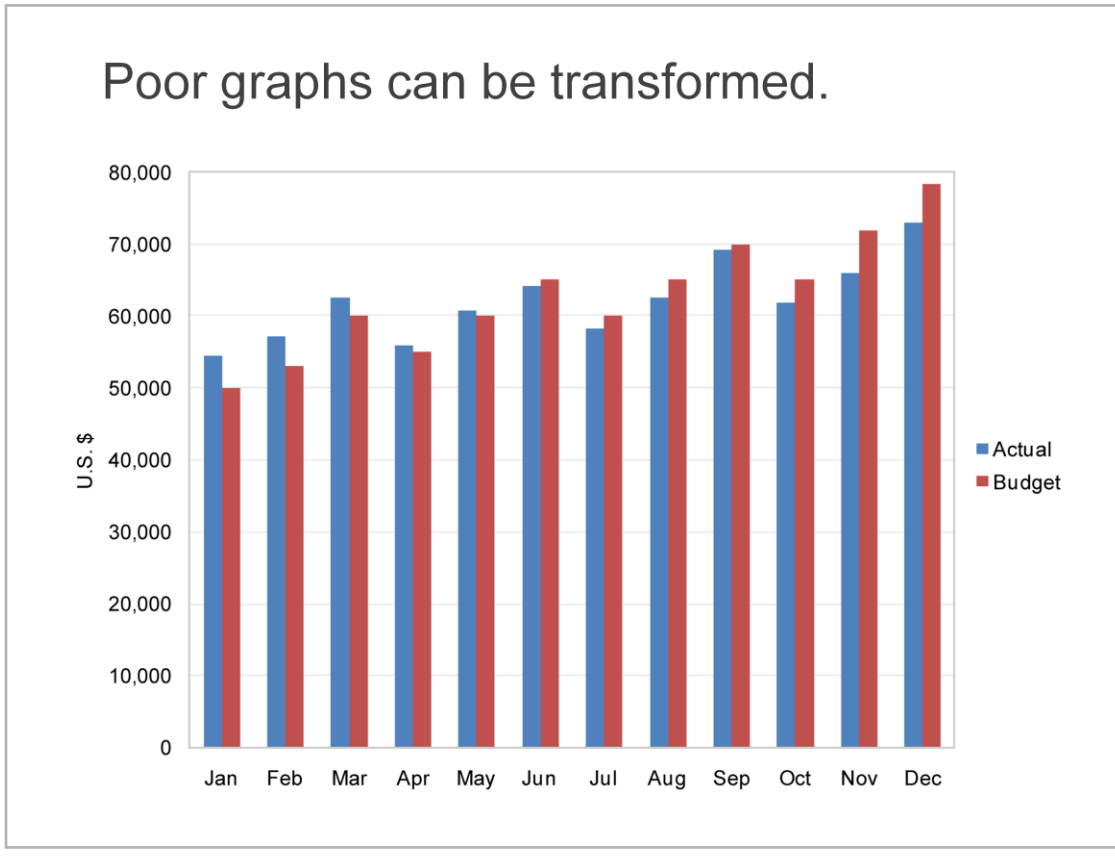

We have now removed the redundant dollar signs and labeled the unit of measure (U.S. $) clearly.

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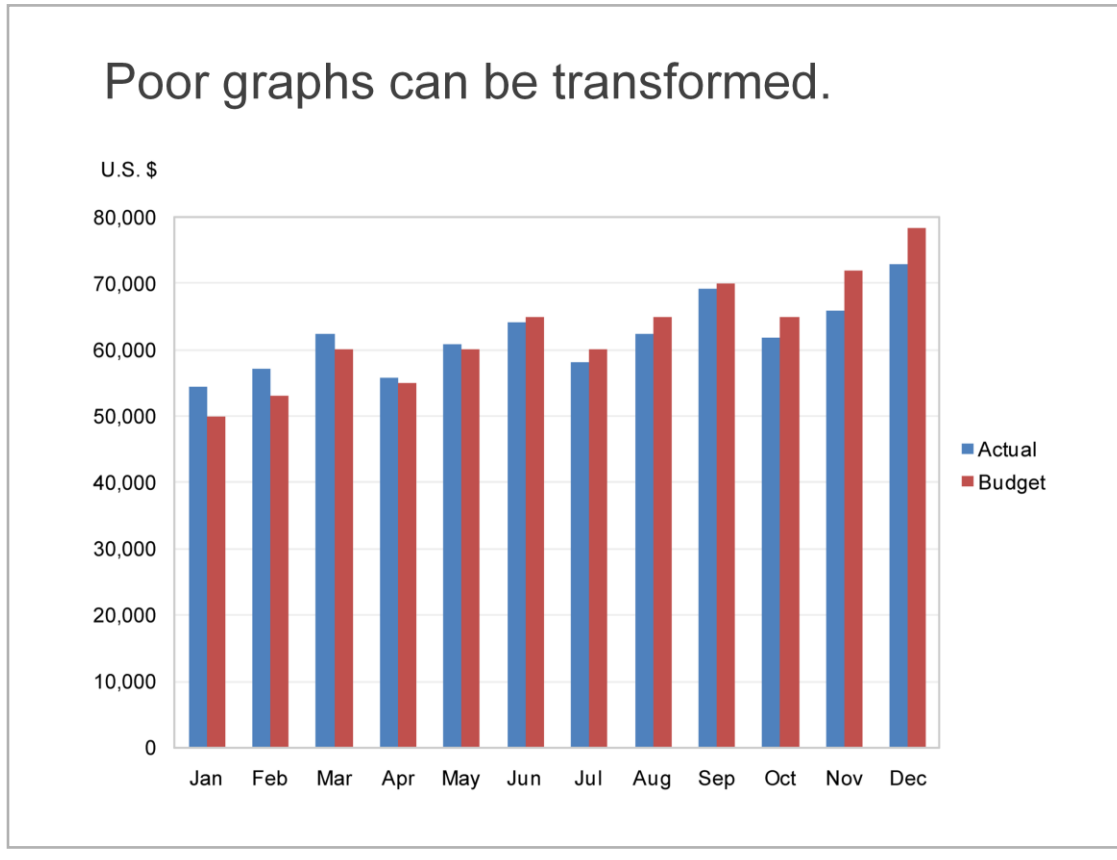

We have now reoriented the Y-axis label to the horizontal and placed it above the axis to make it easier to read.

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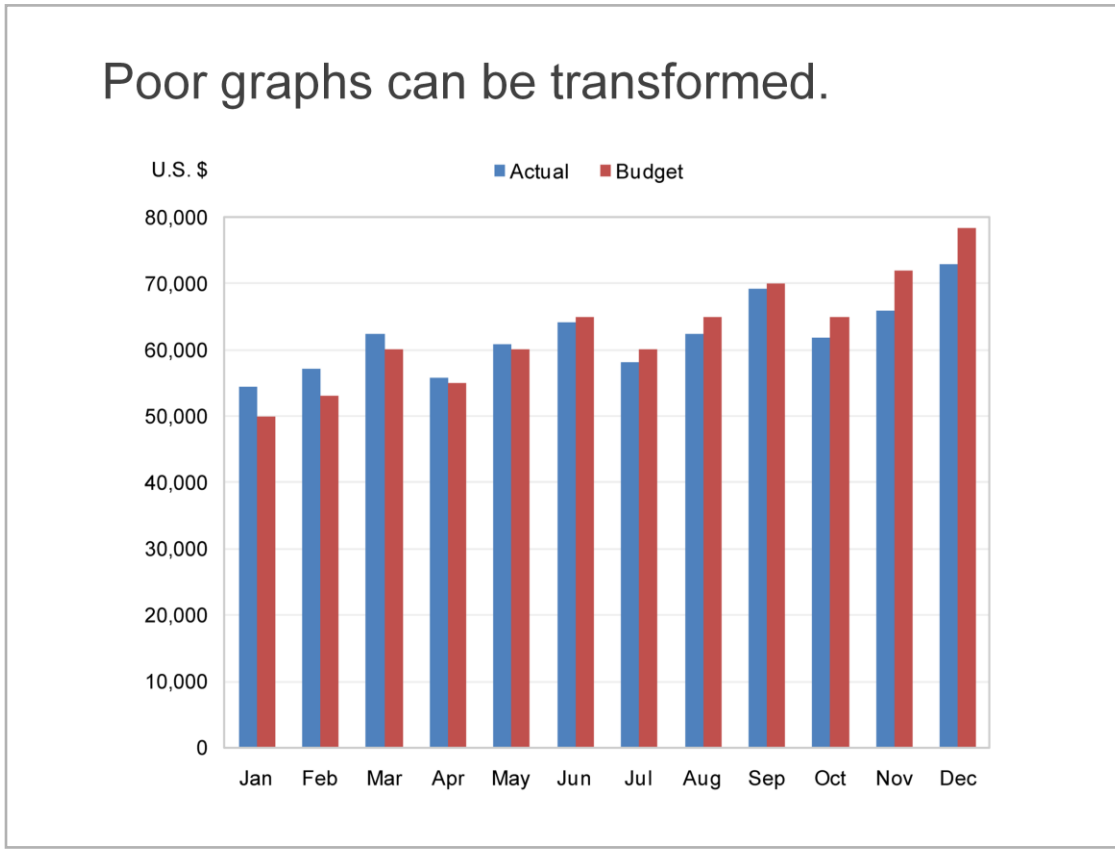

We have now reoriented and repositioned the legend to make it easier to associate it with the data bars.

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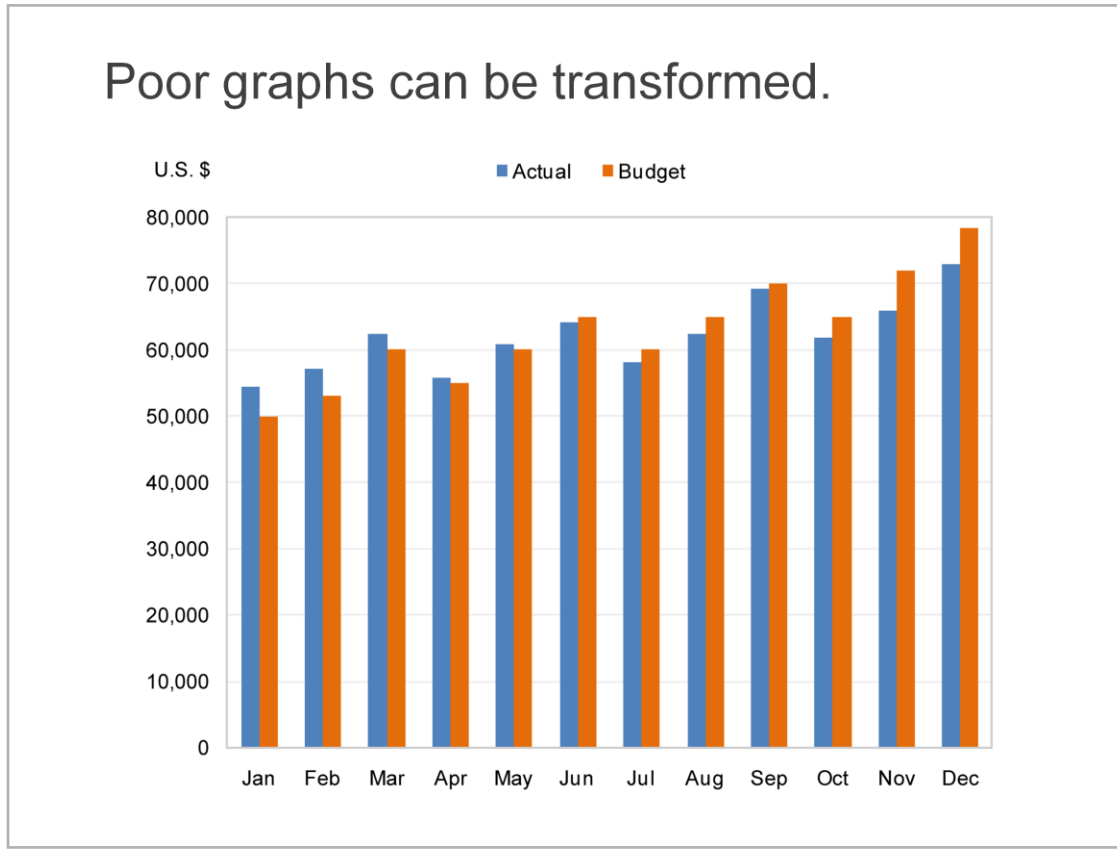

We have now changed the color of the Budget bar to be more visually pleasing in relation to the blue Actual bars. Changing from the color red also removed the possibility people interpreting the data as something bad or a warning, which red is often used to represent.

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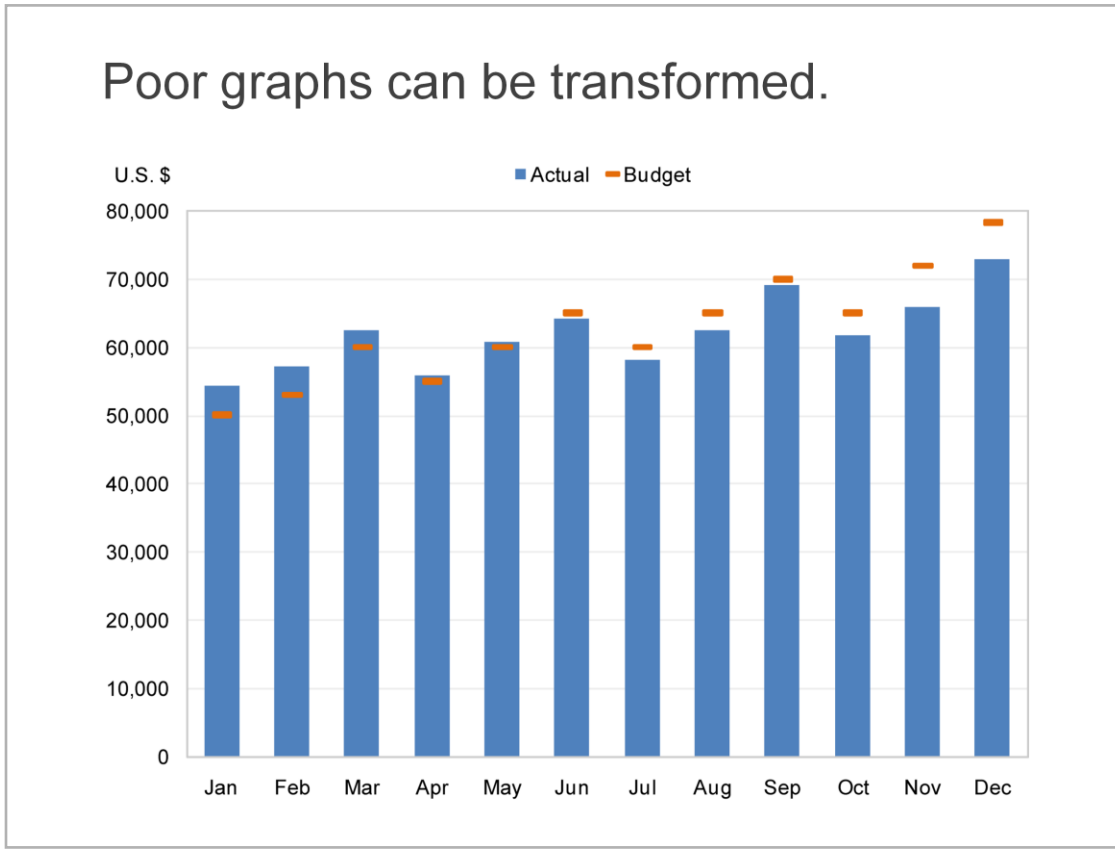

We have now reduced the visual salience of the Budget values, because they are less important that the Actual values, and have done so in a way that reduced clutter.

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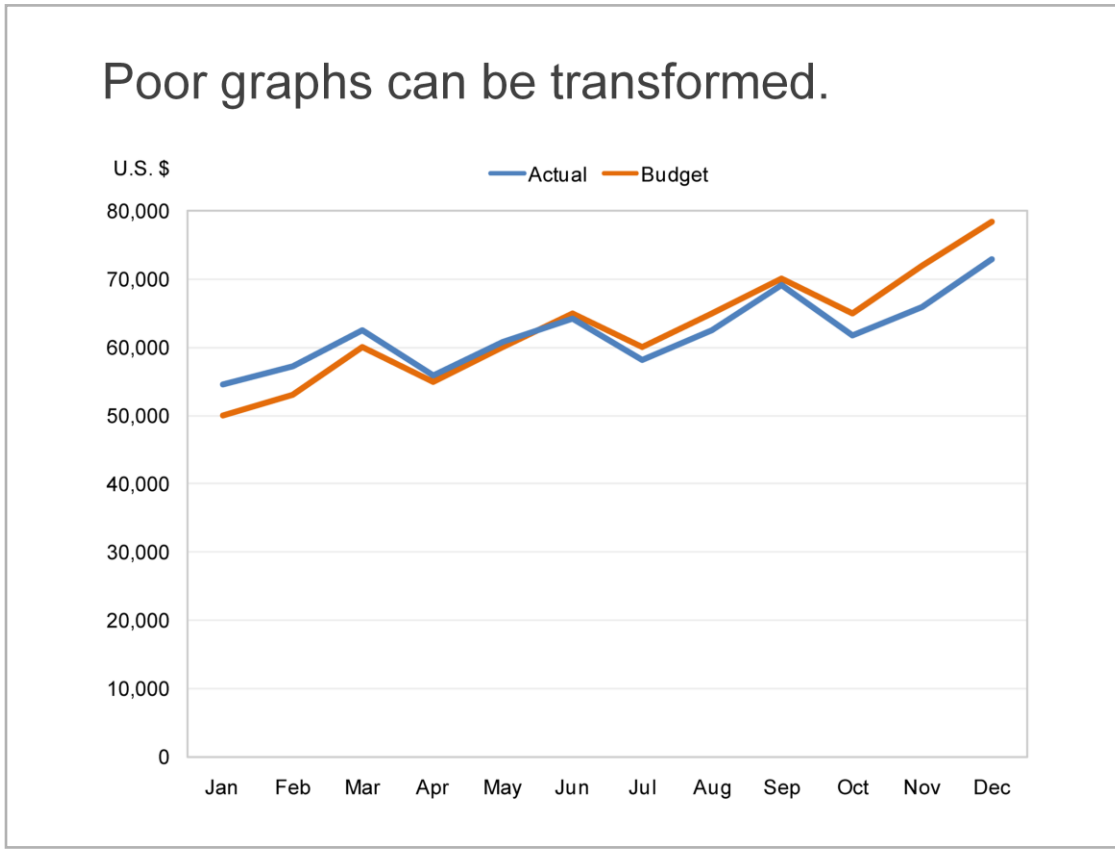

We have now made it much easier to see the pattern of change through time by using lines rather than bars to represent the data.

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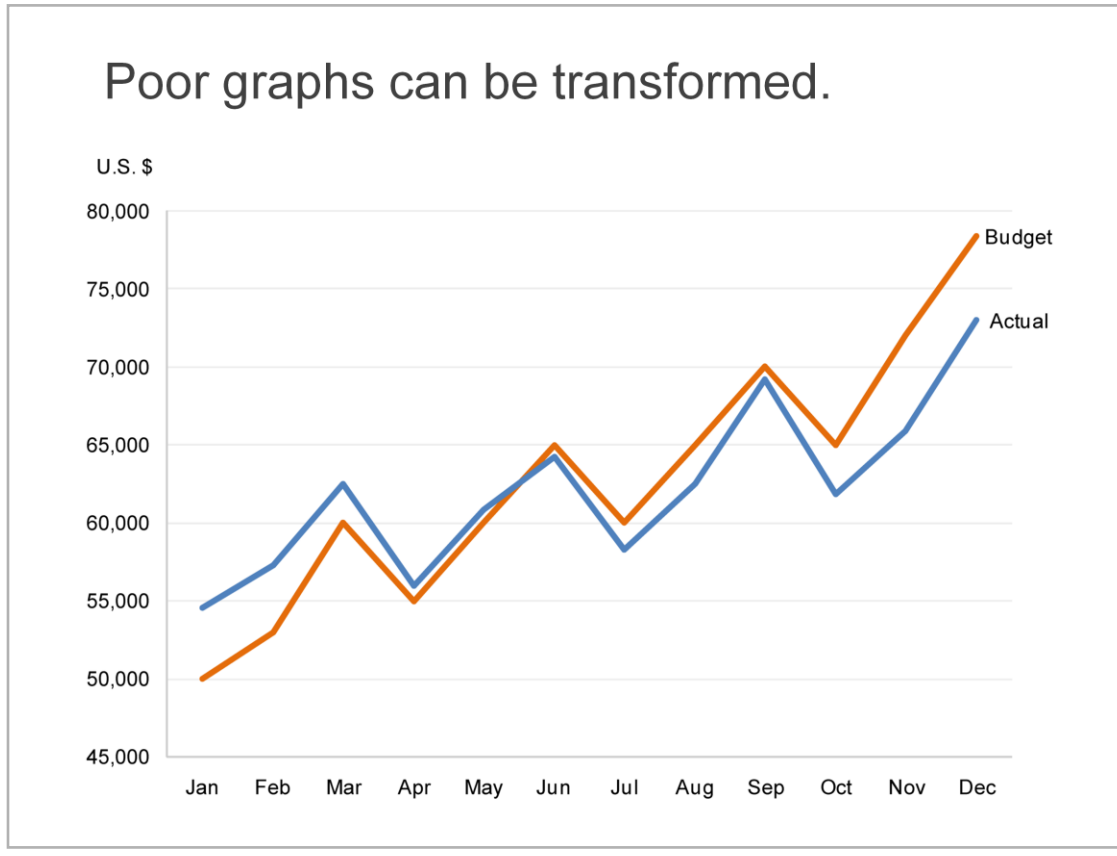

We have now labeled the lines directly, removing the need for a legend.

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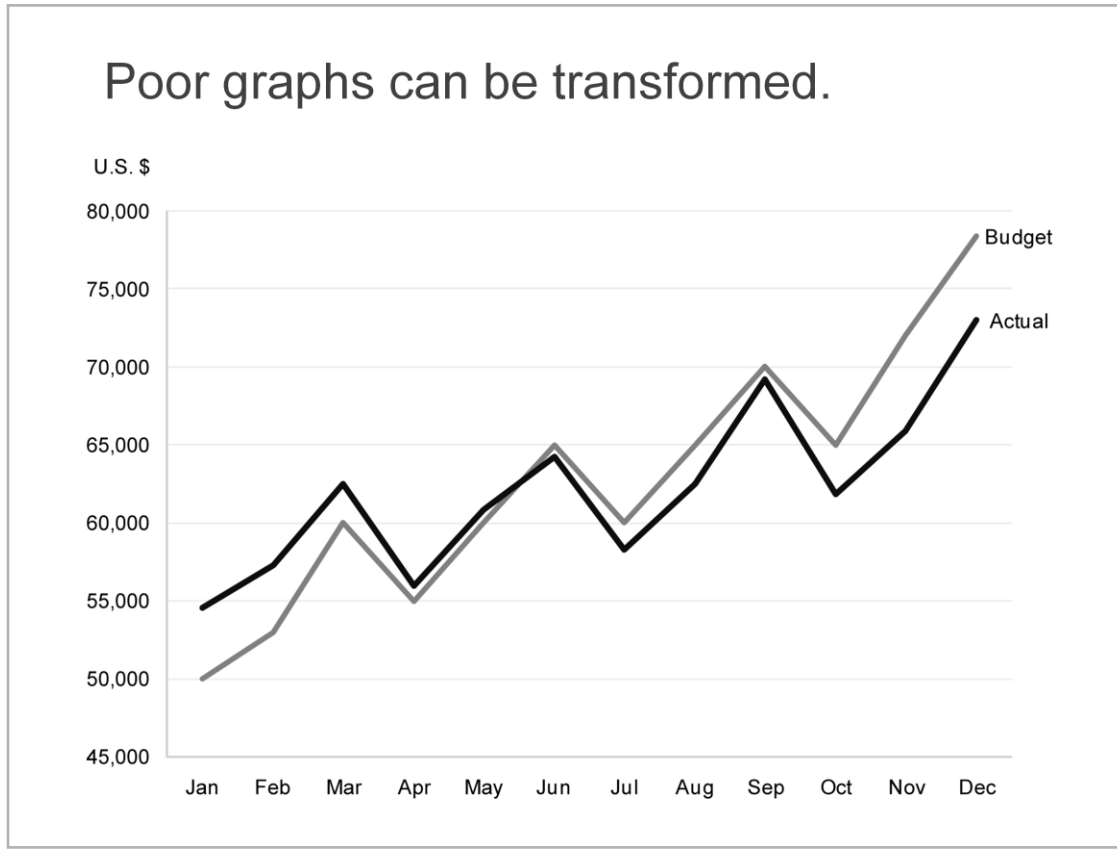

We have now changed the lines to two shades of gray to guaranty that even if the graph is printed on a black-and-white printer or photocopier, they will still look distinctly different from one another.

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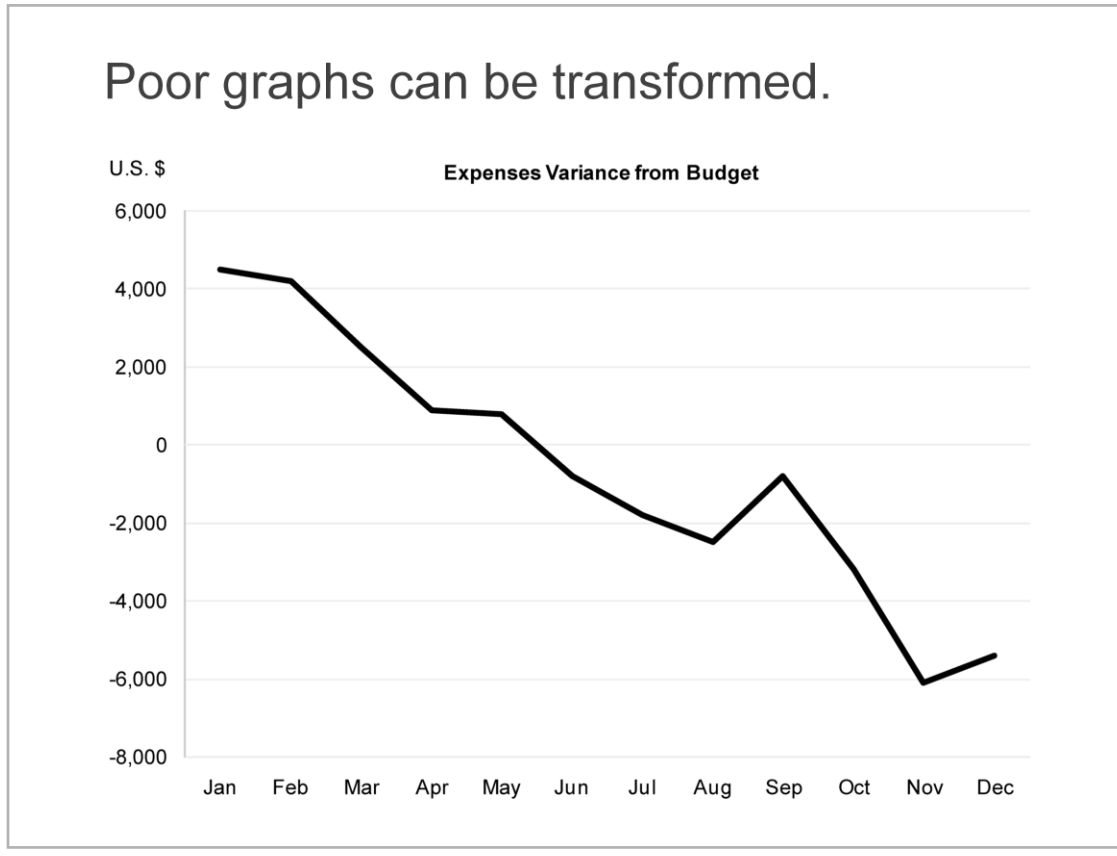

We have now represented the variance of actual expenses from the budget directly, as a single line.

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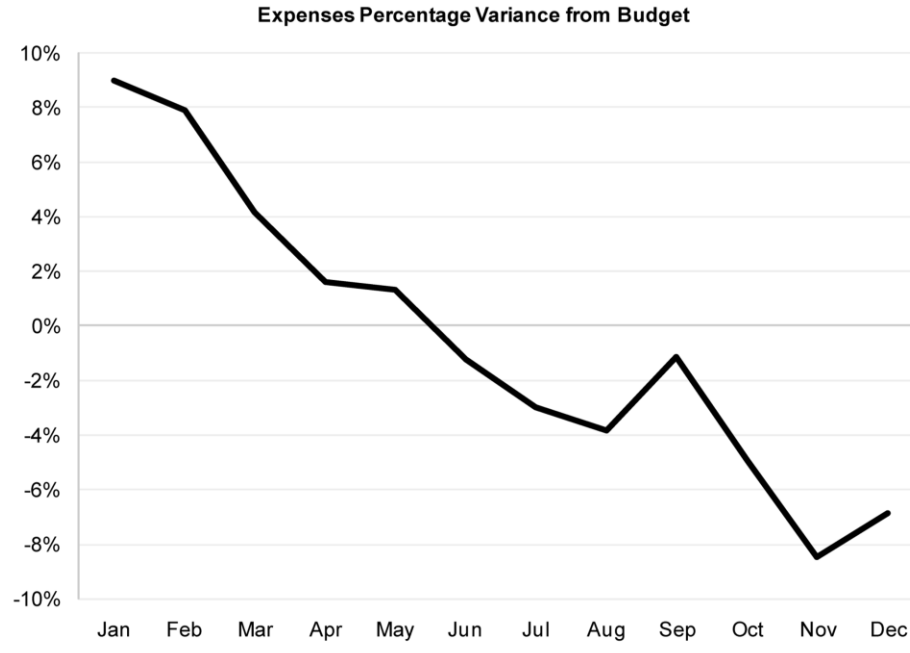
Poor graphs can be transformed.



As our final step, we have expressed variance as a percentage, to provide a better measure of performance.

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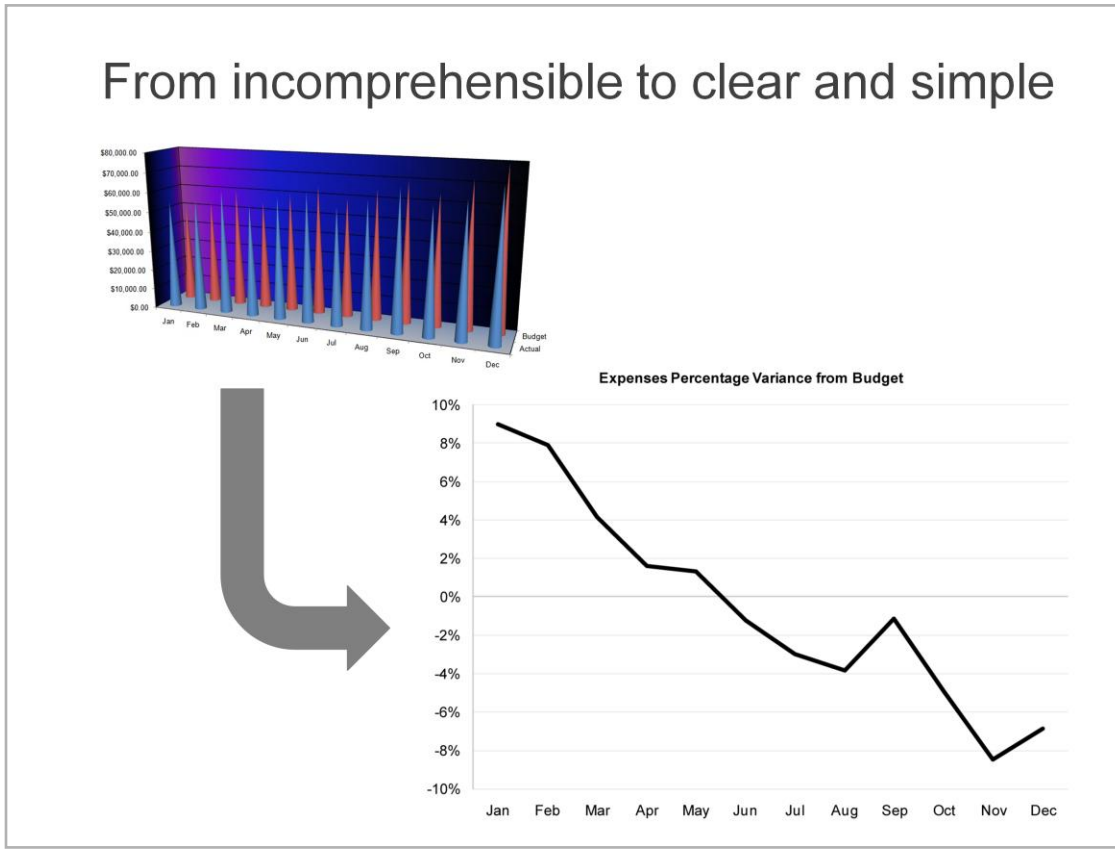

Our final solution, which we produced in sixteen steps, could have easily been our original solution. It usually takes no longer to design effective graphs than those that communicate poorly, if at all.

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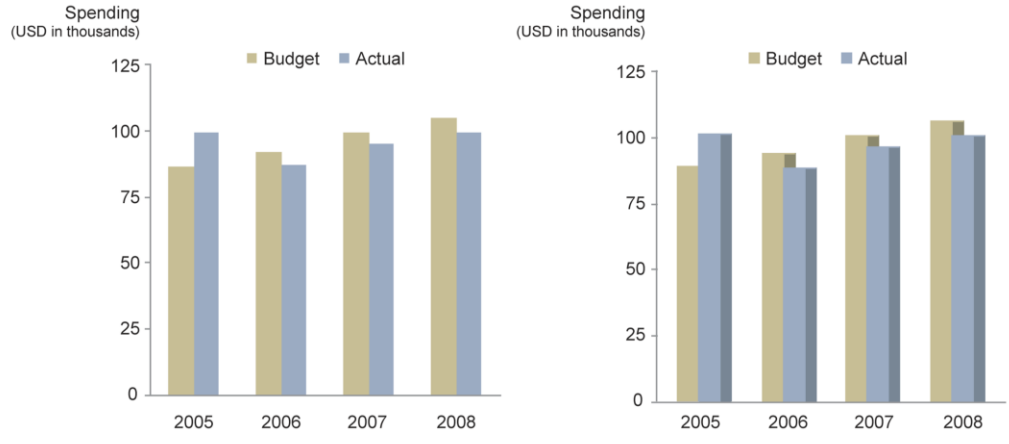
What about 3-D? It's so cute!!!



Adding a third dimension of depth to the bars on the right without adding a corresponding third variable is not only meaningless, it makes it more difficult to decode the data.

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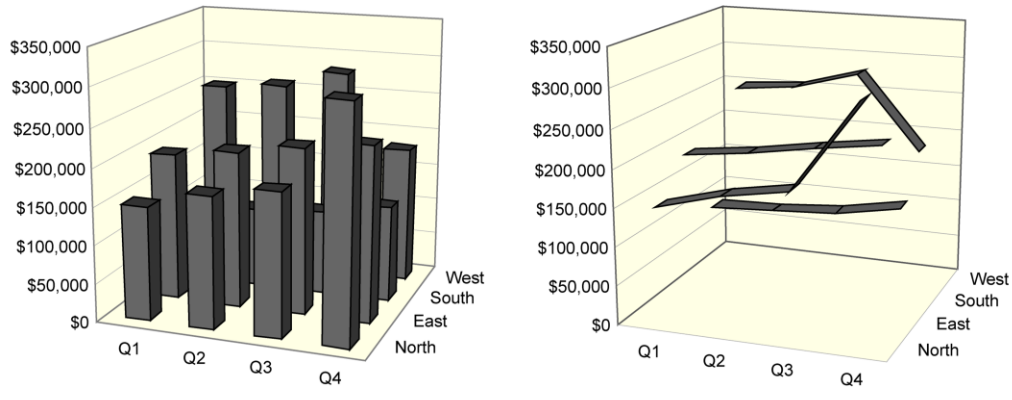
What if there's a 3rd variable?



Can you determine which of the lines in the graph on the right represents the East region? Are you sure?

A third dimension with a corresponding variable is too hard to read.

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Is more color better?

Lots of bright color is great is you're a preschooler. For adults, frequent use of bright colors accosts visual perception. Pastels and earth tones are much easier to look at. Use bright colors only to make particular data stand out above the rest.

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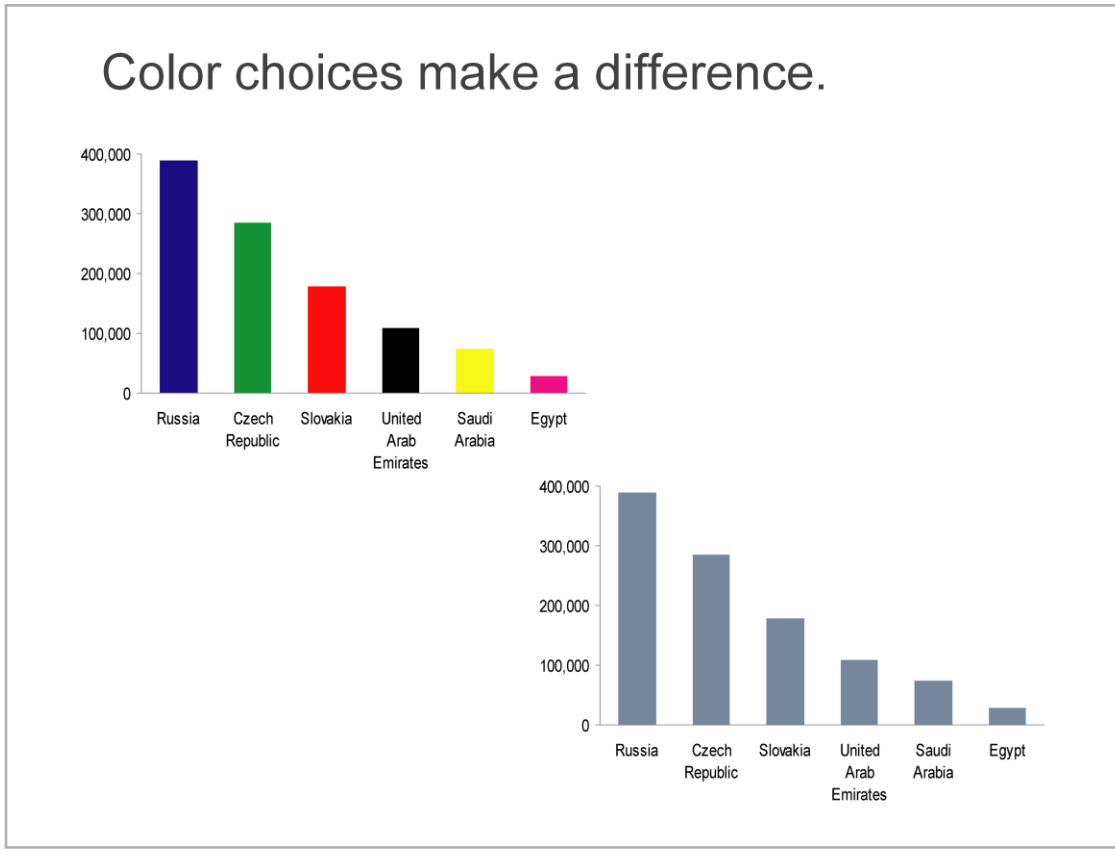

The top graph varies the colors of the bars unnecessarily. We already know that the individual bars represent different countries. Varying the colors visually separates the bars by making them look different from one another, but we want them to look alike to encourage people to compare them and to see the ranking pattern that they form as a whole.

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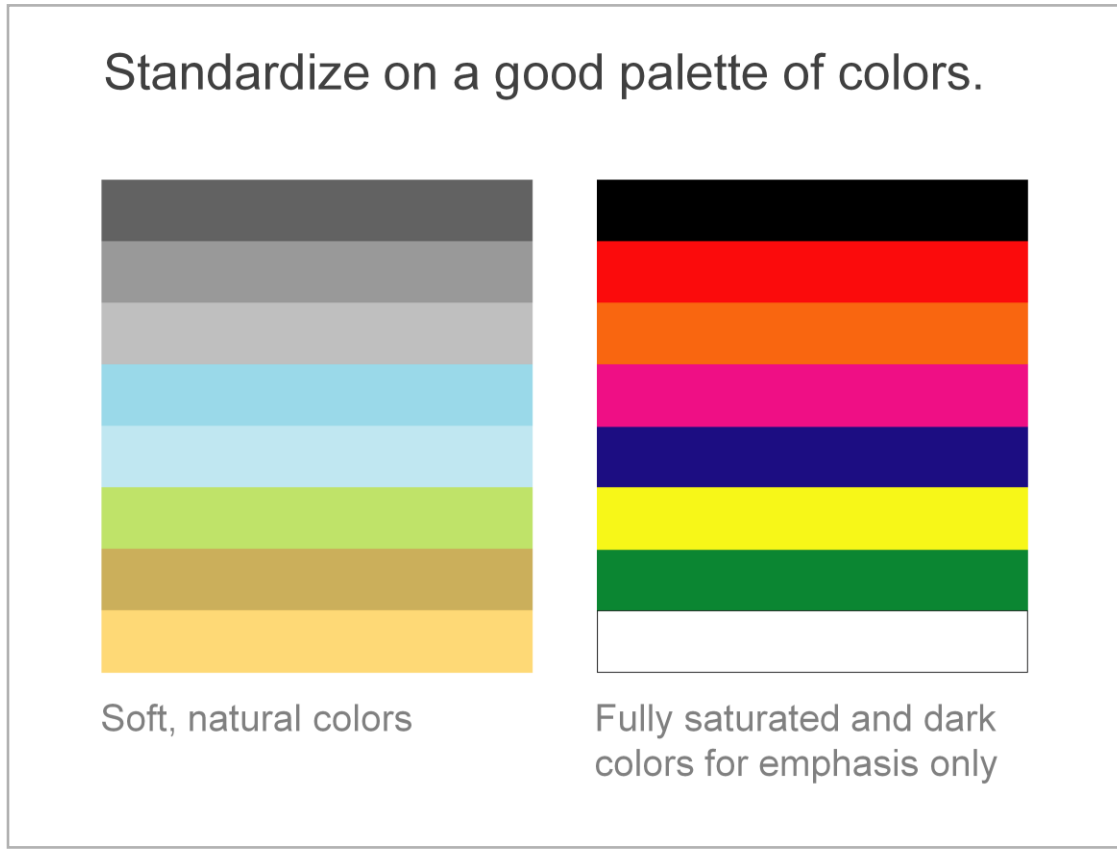

Soft, natural earth tones work best for everything except data that needs to stand out above the rest. Use colors that are fully saturated or dark only for highlighting data. If your software allows you to customize your color palette, it will definitely save you time to do this once, then rely on those colors for all of your displays.

One of the best resources for selecting effective colors for data visualization is the free Color Brewer application that was developed by Cynthia Brewer for use on maps, which can be found at www.colorbrewer.org.

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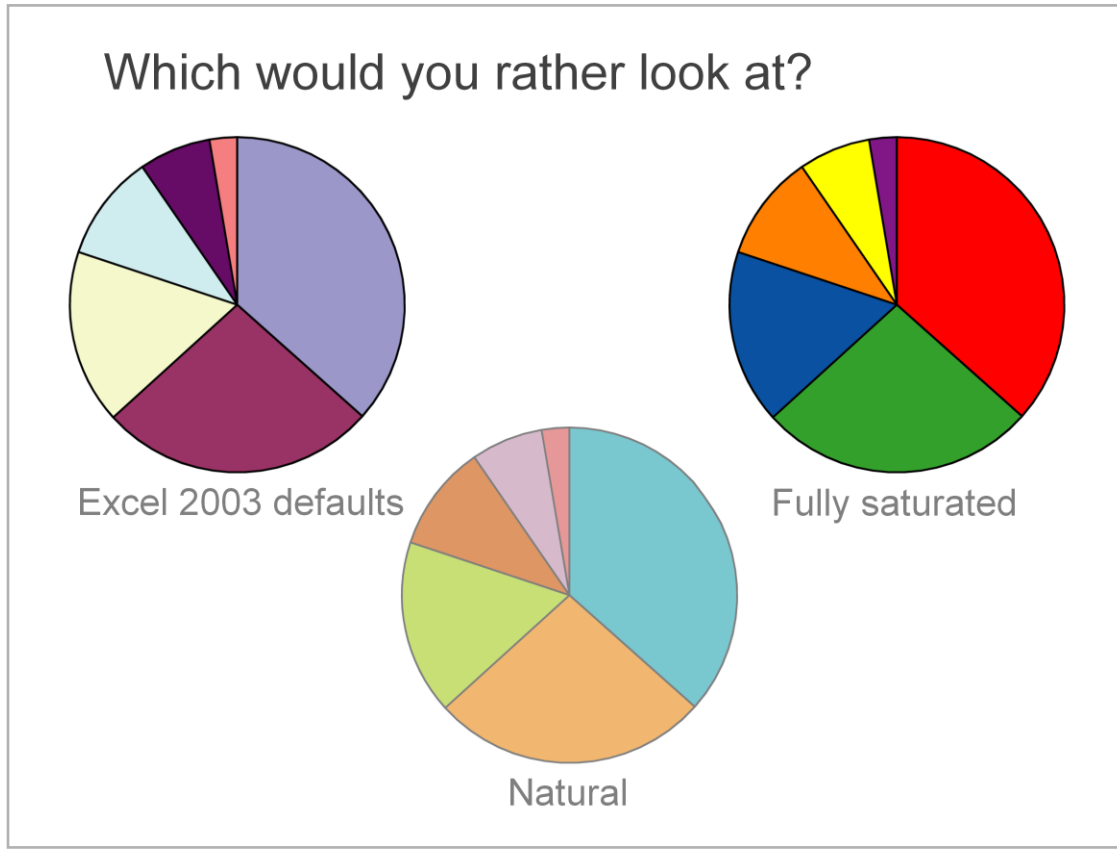

Notice that, despite the softness of the colors in the example of natural colors, they still do the job of separating the sections of these pies just as well as the other examples, but do so in a manner that is much more pleasant to look at.

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Although the skills required to present data effectively are not all intuitive, the good news is, they are easy to learn. The resources are available, such as my book *Show Me the Numbers*, but it won't happen unless you recognize the seriousness of the problem and commit yourself to solving it. It is up to you.

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