Presenting Your Results
Presentation Notes

Slide 4:

Have you ever:

- Calculated how long it would take to drive from point A to point B?
- Figured your tax return?
- Prepared your household budget for the month?
- Balanced your checkbook?

If so, you are well prepared to use data effectively.

Chambers English Dictionary defines the word data as follows: data, a plural noun, meaning facts given, from which others may be inferred; singular – datum.

Unfortunately, the very term "data" intimidates many because they assume that using data requires knowledge of complicated mathematical and statistical procedures. To use data effectively, you only need to know how to select the right facts and numbers and to perform the mathematical basics learned in elementary school – counting, adding, subtracting, multiplying, and dividing.

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As we have just learned, data is a collection of facts, such as values or measurements. It can be numbers, words, measurements, observations or even just descriptions of things.

Primary data are data that you gather yourself. These data are usually specific to your organization. Secondary data sources are simply secondhand, existing data sources. The information from the U.S. Census Bureau is an example of secondary data.

Qualitative data is descriptive information; it describes something. It is non-numerical data. Quantitative data is numerical data.

Quantitative data can either be discrete or continuous. Discrete data can only take certain values, like whole numbers. Continuous data can take any value within a range. Discrete data is counted; continuous data is measured.

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Not all data are created equally – some is quantitative, some is qualitative; some is continuous, some is discrete. Another way to differentiate data is by level of measurement. Understanding the differences between these and being able to identify the level of measurement is important in determining how to analyze your data. The four levels of measurement are: nominal, ordinal, interval, and ratio.

Nominal data: The nominal level of measurement is the lowest of the four ways to characterize data. Some might even say nominal measurement is hardly measurement at all. It refers more to quality than to quantity. Nominal data have no order and thus are given names, categories, or labels. Nominal data can be non-numeric or numeric, for example, gender or zip code. Even if the data are numeric, averages and mathematical calculations aren't appropriate with nominal data. For example, adding area code 513 to area code 212 or calculating the average of a list of Social Security Numbers would be meaningless.

Ordinal data: Ordinal data has an order, but the interval between measurements is not meaningful. Ordinal data can be numeric or non-numeric; for example, a ranking of the top ten cities in which to live or the grades earned by students taking a class. Ordinal data show sequence, but you still can't do any calculations with them. For example, if Roger Ebert gave one movie two thumbs up and another movie only got one thumbs up, you couldn't say the first movie is twice as good as the second one. The difference between zero thumbs up and one thumb up is not necessarily the same as the difference between one thumb up and two thumbs up. The interval between measurements is not meaningful.

Interval data: Interval data is data that can be ordered and differences between the data make sense. That is, the difference between 1 and 2 is the same as the distance between 49 and 50. However, with interval data there is no true zero or starting point. Examples of interval data include IQ scores and temperature. You can talk about 30 degrees being 60 degrees less than 90 degrees; however, 0 degrees, cold as it may be, does not represent the total absence of temperature. Interval data can be used in some calculations; however, it cannot be multiplied or divided. For example, even though 3x30=90, it is not correct to say that 90 degrees is three times as hot as 30 degrees. Here's another example: A brownie recipe calls for the brownies to be cooked at 400 degrees for 30 minutes. Would the results be the same if you cooked them at 200 degrees for 60 minutes or 800 degrees for 15 minutes? We'd probably get three different types of brownies: just right, awful gooey, and extra crispy. The problem is that 200 degrees is not half as hot as 400 degrees and 800 degrees is not twice as hot as 400 degrees.

Ratio data: Ratio data is the highest level of measurement. Ratio data has all the characteristics of interval level data plus the presence of a true zero value. Because of the presence of the true zero value, it now makes sense to compare the ratios of measurements. Phrases such as "a third of" and "twice as many" are meaningful with ratio level data. Examples of ratio level data include height, weight, age, and money.

Here's an example: Four people are randomly selected and asked how much money they have with them. The results are $21, $50, $65, and $300.

1. Is there an order to the data? Yes, $21 is less than $50 which is less than $65 which is less than $300.

2. Are the differences between the data values meaningful? Sure, the person who has $50 has $29 more than the person who has $21.

3. Can we calculate ratios based on this data? Absolutely. Since $0 is the total absence of money, the person with $300 has 6 times as much money as the person with $50.

At this point, you might be thinking, "Well that's great, if I'm ever on Jeopardy this might come in handy!" But understanding the different levels of measurement will be very important as you begin to analyze your data.

When you designed your surveys, you made decisions (possibly without even knowing) about the level of measurement and therefore how the data can be interpreted and described. One of the inherent difficulties in designing surveys, that you most certainly have already discovered, is that there are a million and one ways to ask the same question. The solution to this problem lies in what you want the answer to be; or, more precisely, what do you want to be able to say about the answer.

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Here is an example of different approaches that one might take to collect information about the same variable, socio-economic status. Let's say you are interested in describing the composition of your audience/visitors in terms of socio-economic status. (Note: This example is for illustrative purposes. There is no implication that all, or even any, of these measurement approaches are ideal.)

On your audience/visitor survey you could ask the respondent to provide their profession. This could be an open-ended or a close-ended question with categories like those used by the Labor Department in the Standard Occupational Classification system. This would be nominal level data. You could report the number or percentage of people in each profession, but you wouldn't be able to order those professions in any way to talk about those of lower and higher socio-economic status.

Another approach you might take is to ask them their annual income with a list of income categories for them to choose from. This would give you more detail. You would be able to talk some about the income distribution of your audience/visitors, for example 10% have an annual income of more than $150,000. But you wouldn't be able to make statements about the average income of your audience.

Still another approach you might take is to have people rate their socio-economic status on a scale such as below average, average, above average. Again, you could talk about the distribution of your population, such as 30% ranked their socio-economic status as above average. You could also quantify each of the ratings – below average = -1, average=0, above average =+1 – and calculate a mean or median.

A final approach you might take is to ask, in an open-ended question, for the respondent's annual salary. This is ratio level of measurement and you can now talk about the range of incomes and the average income. You can also group the incomes into categories and talk about the percentage of people in each category. This level of measurement gives you the most flexibility in your analytic options.

Now let's test your knowledge. (See **Levels of Measurement Handout**)

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There are many ways to summarize or give meaning to quantitative data. We will discuss the three most commonly used: average, range, and skew.

The **mean** is what most people understand as the average. In order to calculate the mean, all items in the data set are added together then divided by the total number of items.

The **median** is the middle value of the data set when all of the values are placed in order of increasing size. If the sample size is even, the median is defined as halfway between the two middle values.

Deciding whether to use the median or mean depends on how the data are distributed. The average is the typical value of a set of data. If the distribution of the data values appears regular and concentrated in the middle (that is, the archetypal bell curve shape), the mean is usually used. If, however, the data are irregularly distributed with apparent outliers, then the median is preferred. **Outliers** are extreme, unrepresentative, atypical, or possibly rogue observations in sets of data. For example, the average household income in the US is typically reported as a median, not a mean. This is because household income does not have a bell curve distribution. There are a small, but significant group of outliers whose incomes far exceed everyone else's. If the mean were used the average household income would be artificially inflated due to the influence of those outliers.

The **mode** is the least used of the measures of average. The mode is the most frequently occurring observation. A data set with only one mode is unimodal. Some data sets contain no repeated elements. In this case, there is no mode. It is also possible for there to be two or more data values that occur with the same frequency. These distributions are bimodal (two modes) or multimodal (more than two modes). The mode is the only appropriate average for nominal data.

Range is the difference between the highest and lowest data element. Range can also be reflected by reporting the lowest value and the highest value. For example, our audience is aged 17 to 85. The range shows the "spread" of the data values. It is very helpful to report the range in conjunction with the average.

A final aspect of your data that is important to summarize is the distribution of the data. The most common distribution shape is mound-shaped, or bell-shaped (looking like someone just took a basket of something and dumped it out. This is a uniform or symmetric distribution. If, however, the data distribution lacks symmetry, it is said to be **skew** or **skewed**. Data sets in which the bulk of the values are small with some arbitrary large values (like home valuations) are said to be positively skewed. Data with the reverse pattern, that is with the bulk of values on the higher end, are said to be negatively skewed.

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A **database** is a collection of related data stored together in a way that it can be easily retrieved. Microsoft Access is an example of database software, specifically it is what is known as a relational database.

A **spreadsheet** is a grid for organizing data into columns and rows. Spreadsheets are designed to make number manipulation easy and relatively painless. Microsoft Excel is an example of a spreadsheet software.

A common way to summarize or present data is with a standard **frequency table**. A frequency table lists the data categories or classes in one column and the corresponding frequencies in another column. Frequency refers to the number of times each category occurs in the original data. Sometimes, the relative frequency, or percentage, is reported instead of, or in addition to, the actual count.

A **crosstabulation** is a table in which the frequency of the combination of two variables is reported. In a crosstabulation, or crosstab, the categories or classes for one variable are listed down one side of the table and the categories or classes of the other variable are listed along the top of the table. The table then contains the counts or percentages of each combination of categories.

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A table provides a visual display of data that would otherwise be presented in text. A graphical chart provides a visual display of data that otherwise would be presented in a table. Ideally a chart should convey information about the data that would not be readily apparent if it were displayed in a table or as text.

The standards for tabular display of data apply to charts as well – the efficient display of meaningful and unambiguous data. It is crucial to good charting to choose meaningful data, to clearly define what the numbers represent, and to present the data in a manner that allows the reader to quickly grasp what the data mean. Data ambiguity in charts arises from the failure to precisely define just what the data represent.

Every dot on a scatterplot, ever point on a time series line, every bar on a bar chart represents a number. It is the job of the chart's text to tell the reader what each of those numbers represent.

Designing good charts, however, generally presents more challenges than tabular display as it draws on the talents of both the scientist and the artist. You have to know and understand your data, but you also need a good sense of how the reader will perceive the chart's visual elements.

Two problems arise in charts that are less common when data are displayed in tables. Poor or deliberately deceptive choices in graphic design can provide a distorted picture of numbers and the relationships they represent. A more common problem is that charts are designed in ways that hide what the data might tell us or that distract the reader from quickly discerning the meaning of the evidence presented in the chart.

First we will walk through the basic components of a chart and then we will cover the four most common chart types with illustrative examples.

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Before we begin talking about specific types of charts, let's make sure everyone understands the basic elements of all charts.

The **title** is usually found at the top of the chart and offers a short explanation of what is in the chart. The title helps the reader to identify what they are about to look at. It can be creative or simple, as long as it tells what is in the graph.

The **x-axis** usually runs horizontally (flat). Typically, the x-axis has numbers or categories representing time periods or groups that are being compared.

The **y-axis** usually runs vertically (up and down). Typically, the y-axis has numbers for the amount of stuff that is being measured.

The **legend** tells us what each component of the chart represents. Just like on a map, the legend helps the reader understand what they are looking at.

The **source** explains where the data come from. It is important to give credit to those who collected your data, even if it is you!

The **data** is the most important part of your charts. Different types of charts are used to present different types of data. The data are represented as dots, bars, lines, shapes, pie slices, etc.

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Most charts are a variation on one of four basic types: pie charts, bar charts, line graphs, and scatterplots. Choosing the right type of chart depends on the characteristics of the data and the relationships you want displayed. One of the worst disservices that Microsoft Excel has done to mankind is to allow the user to select any one of these chart types regardless of the characteristics of the data. Hopefully this workshop will help you be more deliberate in your charting.

Slide 13:

A **pie chart**, also called a circle graph, is a way of summarizing a set of categorical data. This type of chart is a circle divided into a series of segments. Each segment represents a particular category. The area of each segment is the same proportion of the circle as the category is of the total data set.

A pie chart uses percentages to compare information. Percentages are used because they are the easiest way to represent the whole. The whole is equal to 100%.

Pie charts can be useful when all you want the reader to notice is that there were more of one thing than another. For example, this pie chart clearly shows that 90% of all students and faculty members at Avenue High

School do not want to have a uniform dress code and that only 10% of the school population would like to adopt school uniforms.

The use of pie charts is quite popular because the circle provides a nice visual of the concept of the parts of a whole. Pie charts are also one of the most commonly used charts because they are simple to use. Despite its popularity, however, the pie chart should be used sparingly for several reasons.

First, as a general rule, comparisons of more than one variable provide for more meaningful analysis than do single variable distributions.

Second, they are best used when there are no more than six components, otherwise the resulting picture is too complex to understand.

Finally, pie charts are not useful when the values of each component are similar because it is difficult to see the differences between slice sizes. Do you remember as a kid trying to decide which slice of your birthday cake was the largest? Do you remember how difficult that was? It is more difficult for the eye to discern the relative size of pie slices than it is to assess relative bar length.

Nevertheless, people like pie charts. Readers expect to see one or two pie charts at the beginning of an annual agency budget report. But it would be a big mistake to rely on pie charts. And if you ultimately decide to use a pie chart, never make it three dimensional. Three-dimensional pie charts are the worst, as they add a visual distortion of the data. Let's look at an example.

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Here are two three-dimensional pie charts of the distribution of nuclear power stations. Can you see how they differ from one another?

In terms of the data they represent, there is no difference between these two charts. The only difference is the location of the slices. Figure (b) is Figure (a) rotated 90 degrees.

The Soviet Union slice appears bigger in Figure (a) than it does in Figure (b). And the UK slice appears bigger in Figure (b) than it does in Figure (a). In both cases, the differences are specious rather than real and are due to the angles at which the slices are being viewed.

Human perception finds it harder, on whole, to compare angles than to compare lengths. When you look at Figure (a) or Figure (b), you are being asked to make comparisons of a three-dimensional representation on two-dimensional paper of angles at an oblique direction to the direction in which you are looking. It is a tribute to human perception that we are able to do this at all; but it is far from easy to do it accurately. Three-dimensional charts might be aesthetically more pleasing, but they can be seriously misleading.

For those who would ignore all the advice given and insist that good charts must look pretty, Microsoft Excel will satisfy all of your foolish desires. You can make 3-D pie charts that gleam and glisten like Christmas ornaments, to say nothing about what you can do with the 3-D pie chart's cousins…the donut, cylinder, cone, radar, and pyramid charts.

Slide 15:

A **bar chart** typically displays the relationship between one or more categorical variables and one or more quantitative variables. The height/length of the bar represents the values of the quantitative variables. The bars may be drawn vertically or horizontally according to preference and convenience. However, it is conventional to draw the bars vertically whenever possible.

Vertical bar charts are particularly useful for time series data. The space for labels on the x-axis is small, making it ideal for minutes, hours, months, or years. For example, in the first chart, you can clearly see that the number of police officers in Crimeville decreased from 1993 to 1996, but started increasing again in 1996. The graph also makes it easy to compare and contrast the number of police officers for any combination of years.

The second chart is an example of a horizontal bar chart. It displays the country of origin for the immigrant students at Diversity College. In this case, a horizontal bar chart has been used because of the length of the category labels. In a horizontal bar chart, the category labels are displayed horizontally along the y-axis, which makes it easier to display longer category labels.

Whether vertical or horizontal, just like with pie charts, you should never use a three-dimensional bar chart.

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The **group bar chart** is used to display the relationship between more than one categorical variable and a quantitative variable.

This double vertical bar chart compares the number of boys and girls using the Internet at Redwood Secondary School from 1995 to 2002. For each of the reported years, one bar represents the number of boys who use the Internet and the other bar represents the number of girls who use the Internet. What does this graph tell us about the data? It tells us a couple of things. First of all, overall internet usage has generally increased for both boys and girls from 1995 to 2002. It also tells us that while there were more boys than girls using the Internet in 1995-1997, the numbers were roughly equal in 2002. Does this graph tell us that girls are just as likely to use the Internet as boys in 2002? No, because the y-axis is number of students, not percentage of students and we don't know if there are equal numbers of boys and girls in the school.

This double horizontal bar chart compares drug use by 15-year old boys and girls in Jamie's school. For each type of drug, one bar represents the percentage of 15-year old boys using the drug and the other bar represents the percentage of 15-year old girls using the drug. What does this graph tell us about the data? Again, it tells us a couple of things. First of all hashish/marijuana is by far the most commonly used drug among 15-year old boys and girls at Jamie's school. It also tells us that drug use is more common in 15-year boys than 15-year old girls at Jamie's school, with the exception of cocaine use. What we can't really tell is if we have a drug use epidemic on our hands. First of all, we don't know how many 15-year boys and girls are at Jamie's school. And secondly, it is extremely likely that there are several multiple drug users represented here.

Slide 17:

Here's an example of a really bad bar chart. What is wrong with this chart? It's not just that it's three-dimensional, making it very hard to discern differences in bar height. There's also no title explaining what we're even looking at. There's no data source. The y-axis is not labeled. Also, look carefully at the x-axis – the time series is backward.

In addition to these formatting issues, the real story in this data is the difference between private institution enrollment and public university enrollment. This finding is obscured by the inclusion of the community college data which has remained consistently higher and relatively constant during this period.

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Here are the same data with all of the issues addressed. In the first chart, you can clearly see that an increase in enrollment at private institutions has accounted for most of the growth in university and college enrollments in the state during this time period. This disparity is even more dramatic if you graph the annual percentage change in enrollment instead of the actual headcount, as shown in the second chart. This is an excellent example of how careful and deliberate charting can produce dramatically different results using the same data.

Slide 19:
In addition to the standard single or group vertical and horizontal bar charts, there are several other types of bar charts that you might encounter or use.

The stacked bar chart is used to display the relationship of two categorical variables (in the same bar) with a quantitative variable. The stacked bar chart should be used with caution. The stacked bar chart works best when the primary comparisons are to be made across the bottom of the bars. Note how difficult it is to discern differences in the size of the components in the upper parts of the bar.

The dot graph replaces the bars with dots. It allows for more categories of data to be represented in the same chart than if a standard bar chart were used. The dot graph is one of the simplest ways to represent information pictorially, yet it is the chart that is least used. As you can see in this example, the message and the information behind the graph are delivered quickly and easily to the reader.

The pictograph replaces the bars with picture symbols. This pictograph represents the number of elementary children who prefer chocolate chip cookies. As shown in the legend, one symbol represents two students; a half-cookie image is used to represent one student.

The histogram is a type of bar chart that is used to summarize discrete or continuous data that are measured on an interval scale. A histogram has an appearance similar to a bar graph, but there are no gaps between the bars. This histogram shows the number of employees of Acme Corporation in each salary category. Because money is a continuous variable, there are no gaps between the bars.

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Line graphs are more popular than all other graphs combined because their visual characteristics reveal data trends clearly and they are easy to create. A **line graph** is a visual comparison of how two variables – shown on the x- and y- axes – are related or vary with each other. The typical line graph has quantity (for example, dollars or number of people) or percentage along the y-axis and units of time represented on the x-axis. For this reason, line graphs are often called time series charts.

Although they do not present specific data as well as tables do, line graphs are able to show relationships more clearly than tables do. This line graph shows the average number of dollars donated by the age of the donor. According to the trend in the graph, the older the donor, the more money he or she donates.

When drawing a line graph, it is important that you use the correct scale. Otherwise the line's shape can give readers the wrong impression of the data.

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Scaling effects can occur when two variables with numbers of different magnitudes are graphed on the same chart. The variable with the large scale will generally appear to have a greater degree of variation, while the smaller scale variable will appear relatively flat even if the percentage change is the same.

In this chart, ABCorp's stock seems to be growing much faster than XYZCOM's, yet the rate of increase is identical. Each stock increased by a factor of 10 from 1990 to 1999.

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When the differences in scale are so great as to eliminate most of the perceived variation in the smaller-scale variable, you can use a second scale displayed on the right-hand side as in this chart. This chart looks at job approval and unemployment rates during the Bush administration. The scale on the left side represents the percentage of workers who rated their job satisfaction as high as depicted by the black line. While the scale on the right side represents the unemployment rate as depicted by the grey line. While this is preferable to the first graph, the interpretation of this graph may be even more complicated.

Another solution to the scaling effect is to rescale the variables. For example, you could calculate the percentage change from a base year. If you take this approach, the selection of the base year can produce dramatically different results.

Another problem arises with line graphs that are printed in black and white. It is sometimes difficult to separate out different trend lines. Mixing solid, dotted, and dashed lines for each variable may solve this problem, although it is sometimes difficult to distinguish between dotted and dashed lines.

Slide 23:

The scatterplot is often used by researchers to inspect their data before performing additional analyses. **Scatterplots** present measurements of two or more related variables. In a scatterplot, one variable is plotted on the horizontal axis and the other on the vertical axis. Each data item corresponds to a point in two dimensional space. The data points are plotted but not joined. The resulting pattern indicates the type and strength of the relationship between two or more variables.

This graph shows car ownership by household income in Anytowne. The pattern of the dots reveals that car ownership increases as household income increases. There is a positive relationship between these two variables.

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When the data points in a scatterplot form a straight line on the graph, the linear relationship between the variables is stronger and the correlation is higher as in Figure 2.

If the points cluster around a line that runs from the lower left to the upper right of the graph area, as in Figure 3, then the relationship between the variables is positive or direct. That is, an increase in the value of Variable 1 is more likely to be associated with an increase in the value of Variable 2. The closer the points are to the line, the stronger the relationship.

If the points tend to cluster around a line that runs from the upper left to the lower right of the graph, as in Figure 4, then the relationship between two variables is negative or inverse. That is, an increase in the value of Variable 1 is more likely to be associated with a decrease in the value of Variable 2.

If the data points are randomly scattered, as in Figure 5, there is no relationship between the two variables. This means there is a low or zero correlation between the variables.

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Besides portraying a non-linear relationship between two variables, a scatterplot can also show whether or not there are any outliers in the data, as in this chart. Outliers should raise red flags. Given the tightness of the other data points in this scatterplot, this outlier is most likely the result of a data entry error or some other form of measurement error and should therefore be investigated.

Slide 26:

In contrast to quantitative data, qualitative data does not simply count things. Qualitative data is a way of recording people's attitudes, feelings and behaviors in greater depth. One of the beauties of qualitative data is how it can make parcels of quantitative data come alive for the reader.

As data analysis turns to data presentation, it can be easy to loose a sense of place for the data. As the process of winnowing the data begins, the emphasis becomes one of selecting one poignant exemplar after another as all of the significant "wheat" (i.e., that data which is deemed significant or exemplary) gets separated from all of the non-significant "chaff" (i.e., that data which is determined to be non-significant or redundant). To balance this tendency towards data separation and data isolation, researchers have to take great care to situate their data so readers can have an appreciation of "from whence the data came" and can begin to evaluate the meaning of the data in context. Qualitative data helps with this.

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Data presentation can be beautiful, elegant and descriptive. We have already covered a variety of conventional ways to visualize data. Tables, histograms, pie charts and bar graphs are being used every day, in every project and on every possible occasion. However, to convey a message to your readers effectively, sometimes you need more than just a simple pie chart of your results. In fact, there are much better, profound, creative and absolutely fascinating ways to visualize data. Many of them might become ubiquitous in the next few years.

Slide 28:

Some of us find joy in numbers, in the certainty of the second decimal place. But most of us don't. And this is your challenge. How do you communicate numbers with all the enthusiasm and loving detail of a numbers lover to an audience, many of whom find numbers dry and difficult? The short answer is: Keep the enthusiasm and trim the detail. Less really is more when presenting data and it is more effective to breathe life and energy into fewer key points than to try to keep everyone's attention through a zillion lesser points. Here are some presentation tips to improve your personal impact when presenting numbers.

For each and every 1 carat diamond extracted from the earth, miners dig up, sift through, and dump 250 tons of ore. And so it should be with your reports. Keep the sparkly gems and discard the debris. Even people who like numbers struggle to pay attention when numbers are arriving like a hail of bullets from a machine gun. Unless you are addressing a very interested audience, overloading your presentation with data is likely to result in your audience tuning out.

By adding context, you can bring emotional quality to the numbers you are presenting and also frame the numbers in a way that gives them extra meaning. For example, the FAQ section on Coca-Cola's website begins answering the question, "How much sugar is in your products?" with "Coca-Cola contains the same amount of sugar that you would find in fresh orange juice." This is not necessarily about spin, it might simply be to add emphasis.

We find it easier to remember big round numbers, so only present the data to a degree of accuracy as is necessary to make the point honestly. There will be occasions when accuracy is everything. Maybe the 7th

decimal place is an illuminating discovery to a quantum physicist. But for most purposes, rounding makes it easier for the audience to remember the numbers.

There is nothing as dull as a series of bar, line or pie charts. Mix it up! Your charts or data tables will be more effective if the title/header is used to focus the attention of the audience on the message you want them to take from the chart. Use color to direct the audience's eye. Don't make too many different points on the same chart. Too many data points make it a lot harder for the audience to take any meaning at all from what you are saying.

Last, but hugely important, bring the presentation to life by injecting it with your own personality. Lighten it up with some gentle humor. Add a little art.