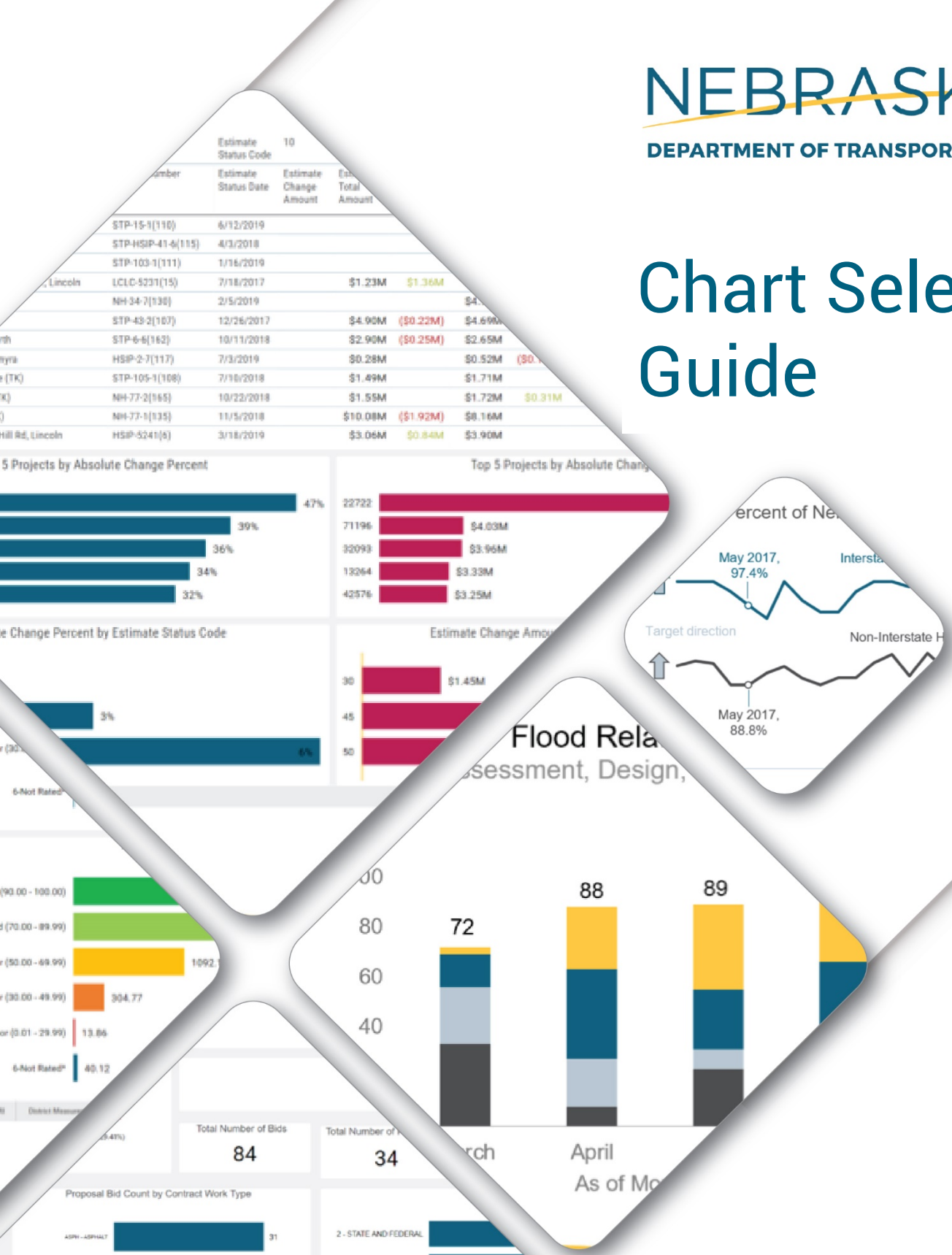
NEBRASKA
DEPARTMENT OF TRANSPORTATION

Chart Selection Guide



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Introduction

Nebraska Department of Transportation (the Department) increasingly uses data dashboards to internally communicate progress and processes. A data dashboard is an information management tool that visually tracks, analyzes and displays key performance indicators, metrics and data points. Many divisions within the Department developed data dashboards over that last few years with support from contractor CATCH Intelligence. These dashboards are read by leadership within the Department to better understand internal performance.

An opportunity was identified to improve several dashboards to further effective performance communication within the Department. To these ends, High Street Consulting and CATCH Intelligence were contracted to review the design and functionality of select dashboards during in-person conversations that took place with several dashboard owners at NDOT Headquarters. Suggested improvements for ten different dashboards were provided during the meetings.

In addition, the following report provides general best practices for data dashboard design and functionality that the Department can apply to future dashboard development. Some of the content from NDOT dashboards are referenced below as best practice examples. The charts and dashboards shown in this report are intended for the purpose of illustrating data visualization best practices. Some of the numbers used in the charts may be placeholder information developed for illustration only. The material in this report should not be used or re-printed as a source for any information beyond its intended use to illustrate chart selection.

Selecting the Right Chart

There are four basic presentation types used in data visualization:

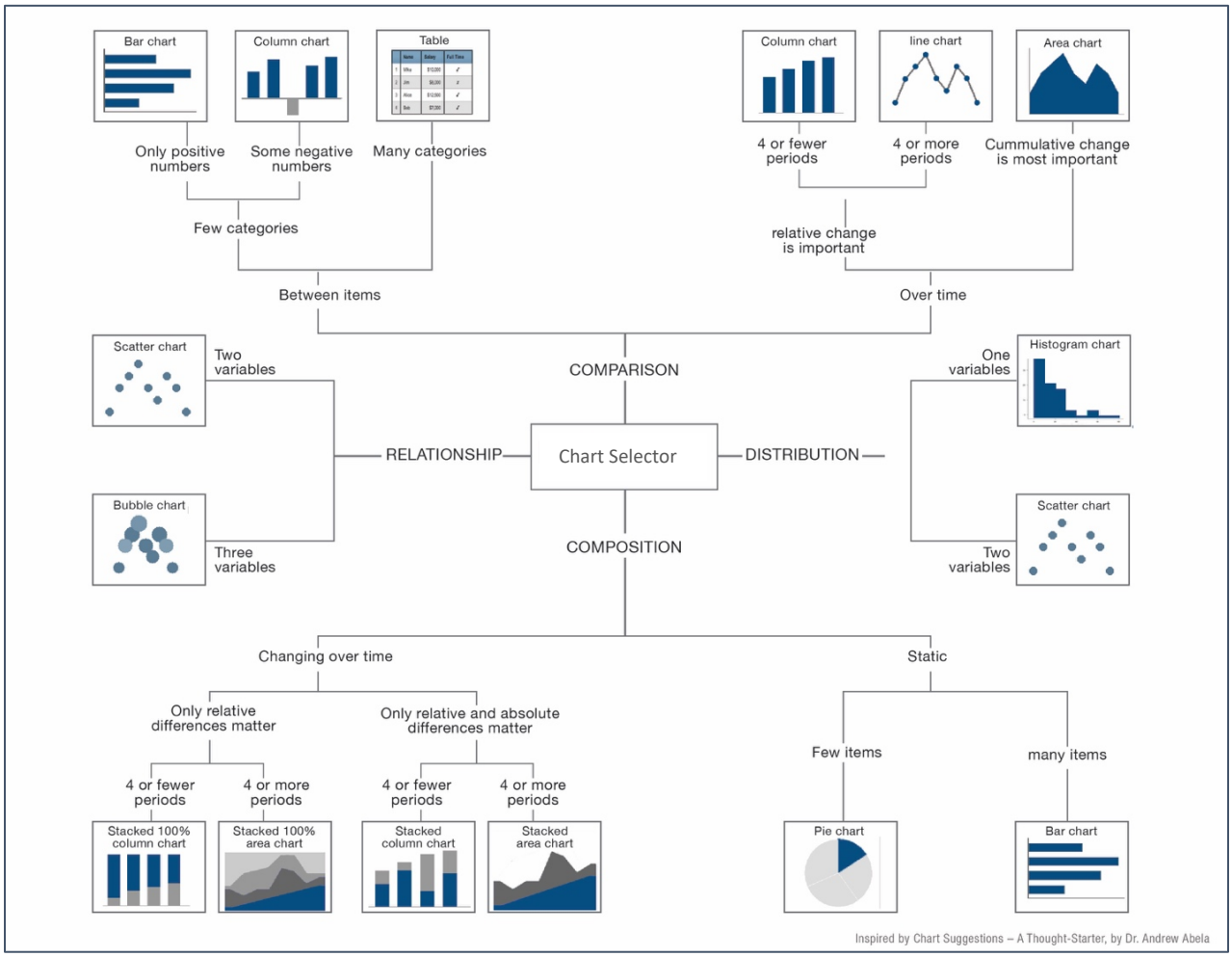
- Comparison
- Composition
- Distribution
- Relationship

Of these four, the most commonly used types of data analysis by far are comparison and composition. To determine which chart is best suited for any given presentation type, it is helpful to think through the nature of the dataset and the content that is most valuable to communicate. For example, how many categories of information do you want to show? Are the categories shown over time? Are they grouped among other categories? Compared in size to one another?

Bar charts are good for comparisons, while line charts work better for trends. Scatter plot charts are good for relationships and distributions. Pie charts should be used only for simple compositions — never for comparisons or distributions. A chart selector is available below. The chart selector displays appropriate visualization options for a given presentation type. [1]

[1] The Chart Selector is developed from Dr. Andrew Abela's, *Extreme Presentation*, 2013 https://extremepresentation.com

Figure 1: Chart Selector

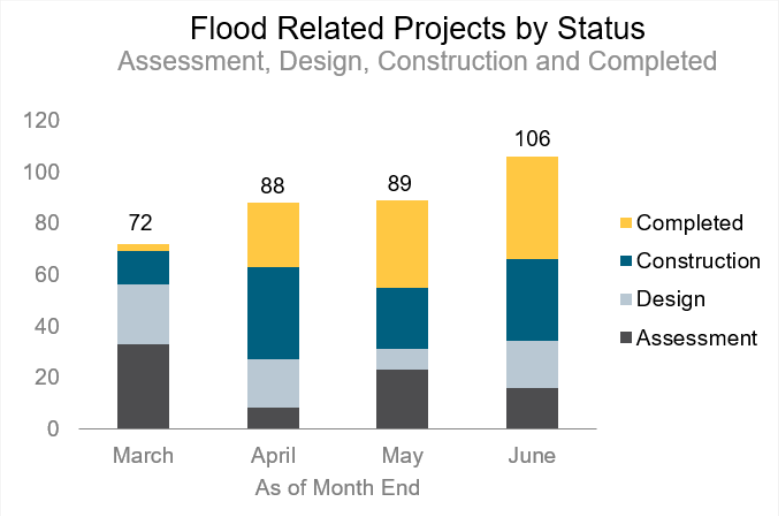


Column Charts

Column charts aptly display comparisons if the number of categories is small, around three to five categories. If there are seven or more categories, a different chart type is strongly suggested. Displaying quarterly data, annual quarters one through four, is a common use for column charts. If the chart is displaying a change over time (years, quarters, months, days, hours, etc) it is always recommended to display the time variable along the horizontal axis, as is shown on the example chart on the right.

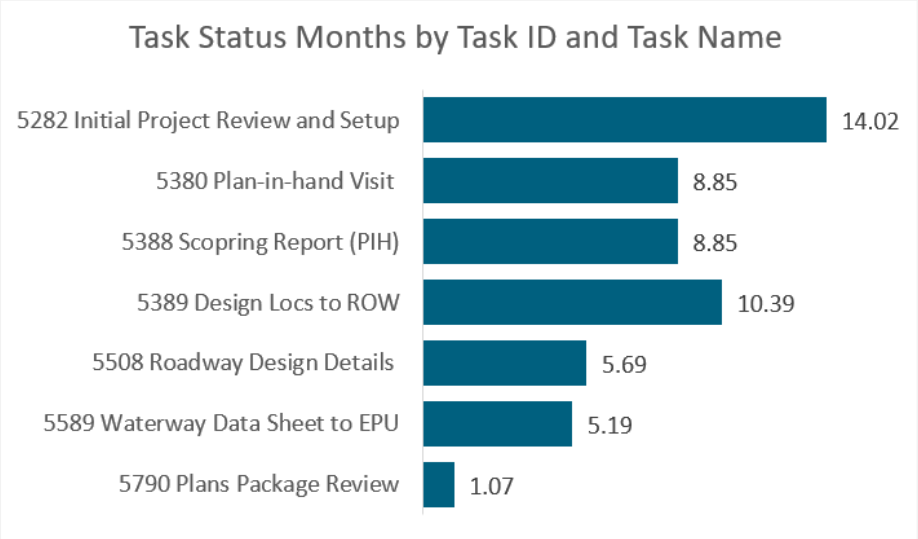
Stacked Column Charts

Stacked column charts to show a composition across several categories, often over time as shown in the example to the right. Stacked column charts can quickly become overwhelming. More than three or four categories in one column becomes too difficult for the reader to consume. Stacked column charts also become a poor chart choice if there is a large difference in the magnitude of the different categories within a column. For example, if one category value is 500 and another category value is 10, it will be very difficult to see the smaller value on the chart. An example of an effective stacked column chart is shown to the right. The color contrast between categories is great enough that the smaller column slices can be seen. The data labels at the top display the total sum of all categories: completed, construction, design, and assessment.



Bar Charts

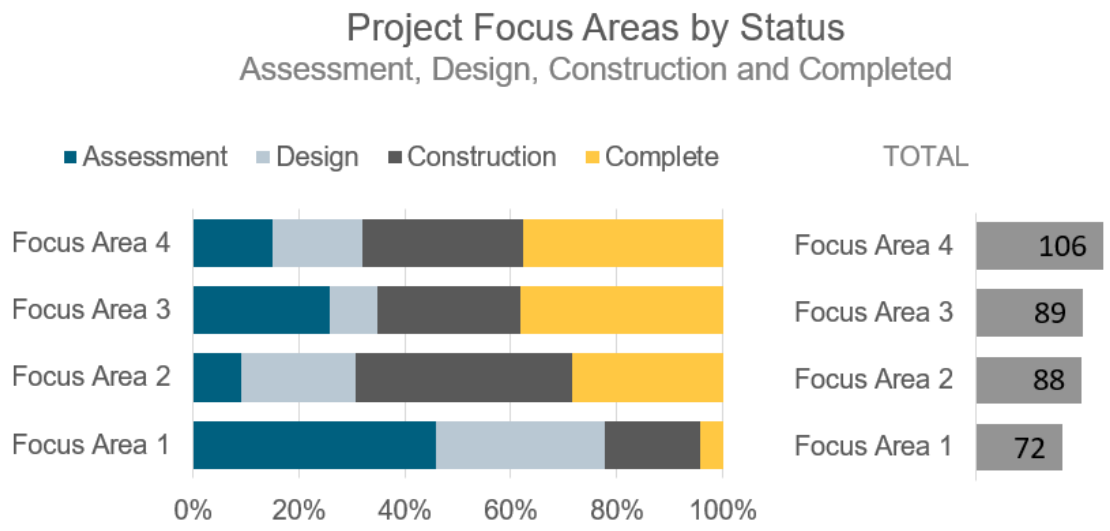
Bar charts are horizontal column charts. If categories shown in the chart have long names, it is best to use bar charts because they give more space for long text. Bar charts are also recommended instead of column chart when the number of categories is greater than seven, or for displaying a set with negative numbers. The example chart below is from the Roadway Design Analysis dashboard and demonstrates using bar charts to help with legibility of longer text labels. A general best practice is to sort the bars by magnitude unless there is a reason to keep the bars in a different order. For example the chart below is sorted based on the roadway order that roadway design tasks are done.



Stacked Bar Charts

Stacked bar charts are meant to allow readers to compare totals across categories and compare the subcomponent pieces within a given category. This can quickly become visually overwhelming. It is hard to compare the components across various categories once beyond the bottom series because there is no longer a consistent baseline to compare. Thus, it is recommended to only use 100% bar charts strategically anchoring the largest or most important segment to the y-axis. Even with 100% bar charts, the visual content becomes overwhelming beyond three or four categories. If there are more than four categories, consider splitting the content into a group of two or more charts.

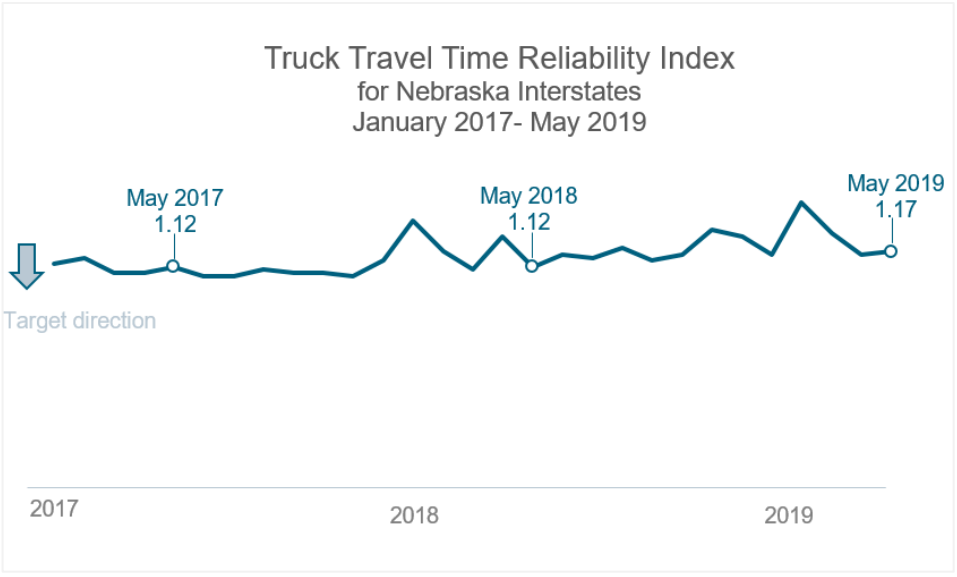
When using 100% stacked bars, context about the overall magnitude of each bar is lost. If the total magnitude is valuable to the overall message of the chart, the stacked bar chart can be paired with a plain bar chart that displays the total. An example is shown below.



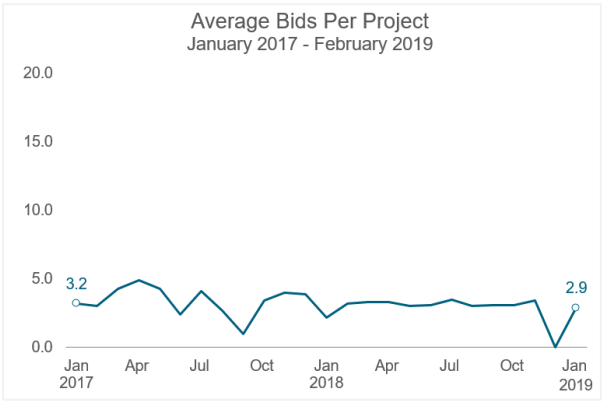
Line Charts

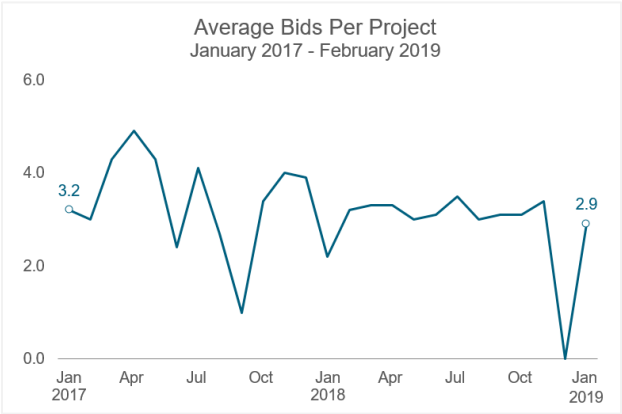
A line chart is the best type of chart for displaying a change over time. Column charts can work for this too, but if there are more than four or five data points, it is best to use a line chart. The chart below shows that change in the truck travel time reliability index over a three year period. If a column chart was used, there would be 36 columns. It is much easier for the eye to track one line versus 36 columns.

Another best practice when using line charts is to label points of interest with callouts. Beginning, end, high, and low points are common points of interest. The chart below is used in a monthly report, with the current month highlighted throughout the dataset to help detect seasonal changes. If there is a performance target associated with the dataset, it can be helpful to indicate the target direction on the chart. Target values can also be displayed on the chart as a dashed line.



Compared with other chart types, it is especially important to remove gridlines from line charts to reduce distraction. The intended message of a line chart is often the rate of change or overall trend, not exact values or comparison. For this reason, it is often appropriate for the y-axis of a line chart to not start from zero, unlike other chart types where the axis scaling is often preferred to start from zero. A good y-axis scale for a line chart will provide sufficient historical context for the dataset and have logical start and end points that are typically rounded to the nearest ten, hundred, thousand, or million, etc. The line charts below demonstrate how the axis scale can drastically change the impression the reader walks away with.



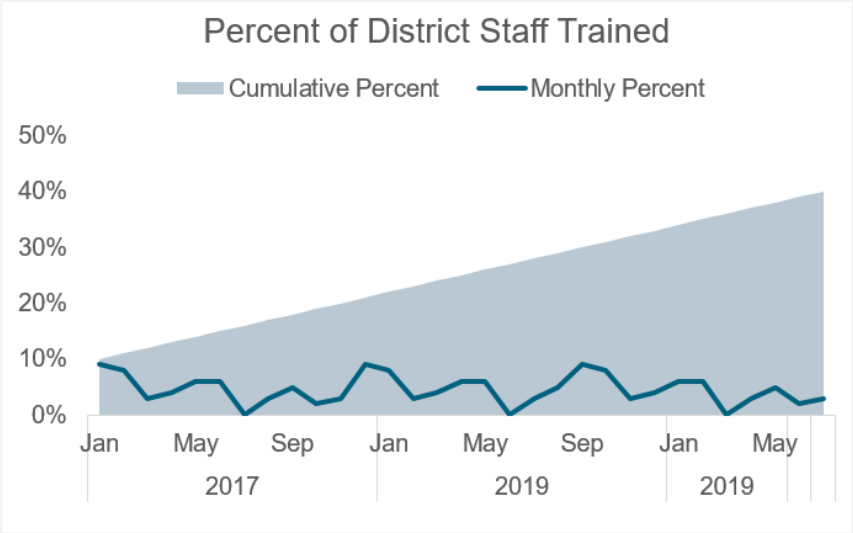


Area Charts

Like a line chart, area charts show trends over time. Area charts are great for showing how a total and their shares are developed over time, but they can be hard to read if there are more than three or four categories shown at one time. Area charts work best if the total is as important as its shares, and the cumulative change is an essential part of the message. Area charts also work best for considerably large differences between category values. If the differences between category values is small, consider a line chart instead. Compared to an

area chart, the y-axis of a line chart does not need to start at zero, and the line chart's y-axis can be stretched to show the tiny differences.

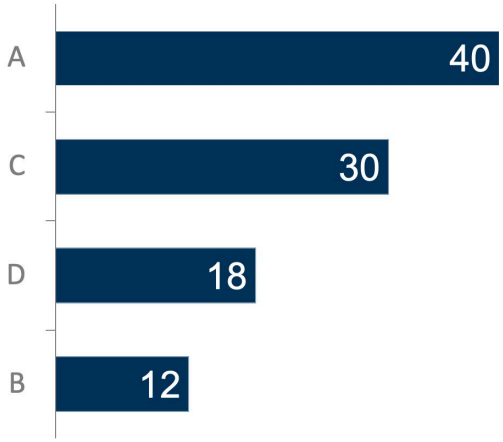
The example area chart below shows only one category value, the cumulative percent of trained staff. The area chart is compare with a line chart that shows a monthly non-cumulative total from the same dataset.

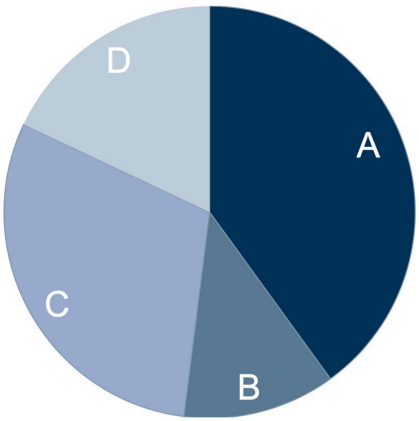


Pie Charts

Pie charts are a commonly misused chart type. Beyond three or four categories, the pie chart is difficult to read. And it is generally preferred to use a bar chart over a pie chart to more clearly display the difference between categories. The eye has a hard time distinguishing size differences based on angle size. However, pie charts are ideal for comparing two or three percentages with each other. The percentages within the pie chart should always be part of the same total.

The example below compares the same numbers used in both a bar chart and a pie chart. If you want to quickly see the difference in value between A, B, C and D which chart is easier to read?





Tables

Tables are often used for comparison, composition, or relationship analysis when there are only few variables and data points. Big picture messages are much easier to see and to remember when presented in charts instead of tables. However, a table is best when readers need to compare or look up specific values. The table below uses several best practices including:

- Gridlines placed strategically to group similar columns, i.e. around Facility A and B
- Light shading of every other row
- Bold text for totals and subtotals

	Facility Type A			Facility Type B			
State	Rural	Urban	Subtotal	Rural	Urban	Subtotal	**TOTAL**
A	552	1,175	1,727	131	2,629	2,760	**4,487**
B	1,229	2,184	3,413	-	10,475	10,475	**13,888**
C	736	4,351	5,087	405	5,530	5,935	**11,022**
D	610	89	699	536	13,709	14,245	**14,944**
E	470	1,750	2,220	-	20,607	20,607	**22,827**
F	597	5,901	6,498	-	8	8	**6,506**
G	564	4,641	5,205	-	5	5	**5,210**
H	214	3,213	3,427	-	-	-	**3,427**
I	133	991	1,124	-	328	328	**1,452**
Subtotal	**5,105**	**24,295**	**29,400**	**1,072**	**53,291**	**54,363**	**83,763**