May 14, 2018

Regional Transit Board of Directors
Henry Li, General Manager/CEO
1400 29th Street
Sacramento, CA 95816

Re: Best Practices in Data Visualization

Dear Board of Directors and Mr. Li:

The Sacramento Transit Riders Union (SacTRU) members have previously expressed our dissatisfaction with SacRT's overuse of pie charts to explain complex financial information to members of the public. During our last membership meeting, we discussed best practices for data visualization and wanted to share our recommendations with staff.

When to Use a Pie Chart

Pie charts are best used when making part-to-whole comparisons and should be used to describe nominal data, such as demographics, and illustrate a numerical proportion. Each section expresses its quantity through the size of the central angle in proportion to the others. What makes this visually powerful is their ability to quickly communicate obvious differences in data categories or showing progress towards a goal.

The trouble with pie charts, even the most expertly constructed pie charts, is that they can be easily misinterpreted. The problem stems from the inability of our visual system to accurately perceive areas and is compounded by the angles created by the wedges of the pie. They're hard to read because our brains aren't great at interpreting the relevant size of different slices of the pie. If the sections of the chart are similar, we can't easily tell which piece is bigger. We have trouble distinguishing proportion in the segments, meaning the impact of the data is lost or misinterpreted. In this case, they make the argument that it is better to use a bar chart when specific numbers have importance or large data sets are a factor.

Best Practice No. 1: Visualize no more than 5 categories per chart.

It is difficult to differentiate between small values; depicting too many slices decreases the impact of the visualization. If you've got only two or three slices of the pie, and all those slices are very different, then you don't have much of a problem. But that's not the case with most pie charts. All too often, we try to squeeze too much data into them – not only do we end up with lots of slices, we get too many similarly sized slices.

Sample RT Pie Chart with Many Categories:
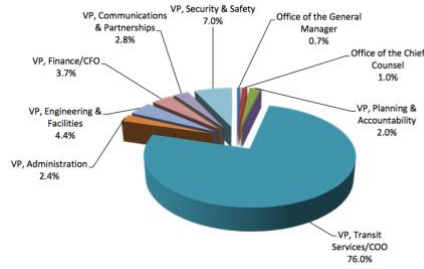
The pie chart above has 9 categories, most of which are so small that differentiating any meaningful information between the size of their slices is difficult.

Best Practice No. 2: Don't use multiple pie charts for comparison.

Slice sizes are very difficult to compare side-by-side. Just one pie chart is hard to read, lining up a row of them for people to compare makes things even worse. If you want to compare two sets of data, use a stacked bar chart.

Sample RT Pie Chart Comparing Change:
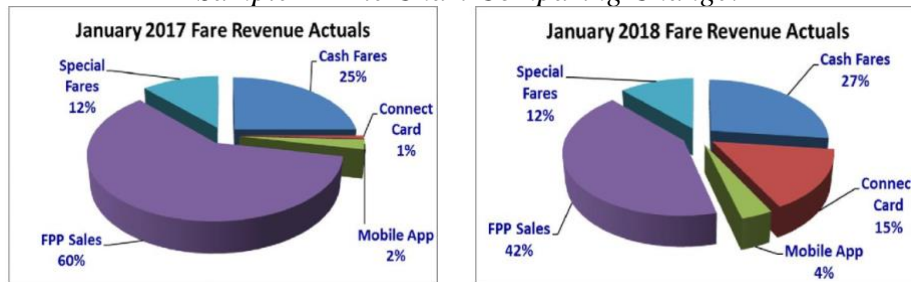
The pie chart above compares data from one year to the next. Displayed in a pie chart, the information is difficult to quickly compare. It is difficult to discern what the important information is in this pie chart. Is it the fact that FPP Sales have shrunk so much or that connect card and mobile app proportions have increased? It is almost impossible to tell that cash fares have increased by 2 percent.

**Best Practice No. 3: Order slices correctly.**

Place the largest slices from "12" at the top (like on a clock) and work your way around the circle. This should be a default setting in excel. When pie charts are rotated we lose the reference line at 12 o'clock and it becomes more difficult to identify relative proportions of the wedges.

There are two ways to order sections, both of which are meant to aid comprehension:

Option 1: Place the largest section at 12 o'clock, going clockwise. Place the second largest section at 12 o'clock, going counterclockwise. The remaining sections can be placed below, continuing counterclockwise.

Option 2: Start the largest section at 12 o'clock, going clockwise. Place remaining sections in descending order, going clockwise.

Sample RT Pie Chart with Disordered Slices:
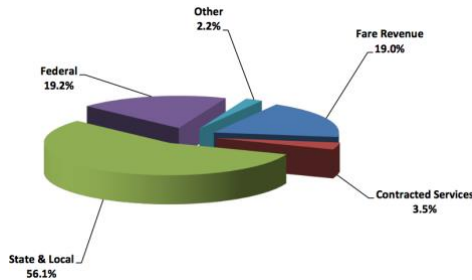
The pie chart above is rotated and has no discernable start location. It is difficult to instantly visually identify where the eye should start looking and how to make comparative inferences from the information. With small and large slices mixed in with each other it is not easy to understand proportional difference.

Best Practice No. 4: Don't use 3-D pie charts.

They compound the difficulties associated with accurately assessing the areas of angles. Due to the foreshortening the angles and proportions are hard to measure. They make some slices of the pie seem larger than others. This makes the chart even harder to read, and, done deliberatively, is deceptive.

Sample RT 3-D Pie Chart:
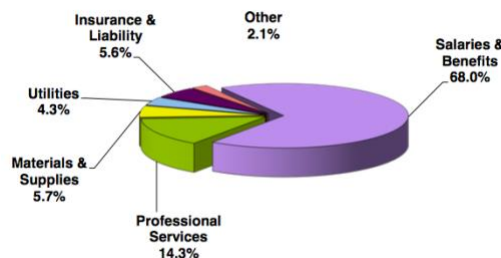
The pie chart above is 3-D and tilted to a point where it is almost flat. The angle almost completely illuminates the light pink slice from sight. It is difficult to understand and fails to communicate obvious differences in data that make pie charts so impactful.

Best Practice No. 5: Don't Explode the pie.

Analysts sometimes choose to explode pie charts to add emphasis to a wedge, but there are *very few* situations when this option adds to the understanding of the chart. Pulling apart wedges should be avoided because it increases the difficulty of interpreting the relative proportions of the wedges. If you *must* explode a pie chart, only separate one wedge from the rest, don't separate all wedges.

Sample RT Exploded Pie Chart:
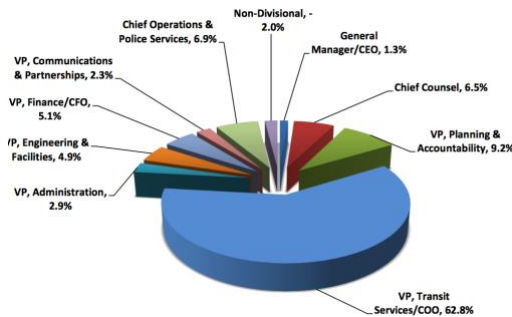
The pie chart above suffers from almost all of the problems listed previously. It contains 10 different categories, it does not start at 12 o'clock, the largest section is on the bottom, the other pieces are not arranged in descending order, it is 3-D, tilted, and popped out. It would be difficult for a chart savvy consumer, let alone an interested member of the public to quickly discern any meaningful information from the pie chart.

Luckily, there are many alternatives to pie charts! We hope that these tips are helpful and improve data visualization best practices at SacRT and improve the way that information is communicated to members of the public. Please include this letter in the public record.

Sincerely,

Sac TRU