ARROW CHARTS: A NEW WAY OF DISPLAYING MULTIPLE COMPARISON DATA

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KEY WORDS: Graphs, Pie Charts, Multiple Comparisons

Executives at many corporations routinely utilize extensive, tabular dumps of comparative data for monitoring business conditions. At AMD, for example, senior managers received --- on a weekly basis --- a forty page document of detailed tables listing the bookings and billings performance of all divisions for periods including the present quarter, the same quarter last year, the previous quarter, and the year to date. The sheer mass of numbers generally obscured the information content of the data. One senior officer asked, "How can I get a quick and accurate picture of the health of the company without plowing through all these figures?" Obviously, a graphical summary was required, but what form should it take?

Consider the simplified example in Table 1 from a recent article in the *San Jose Mercury News,* the local, metropolitan newspaper. The table provides a forecast of changes in the locations of personal computer (PC) purchases over a three year period. Four categories are compared from 1992 to 1995.
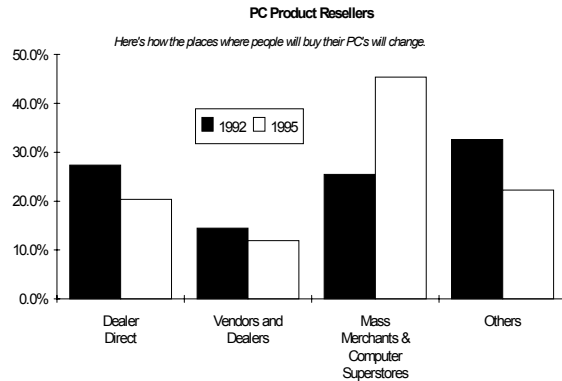
Table 1. PC Product Resellers

Here's how the places where people will buy their PCs will change

	1992	1995
Dealer Direct	27.4%	20.4%
Vendors and Dealers	14.5%	11.9%
Mass Merchants & Computer Superstores	25.5%	45.4%
Others	32.6%	22.3%

Source: Meran Information Services

The two most common methods of graphically displaying such data are bar charts and pie charts, each method having both desirable and undesirable features. Figure 1 is a bar chart representation of the data.
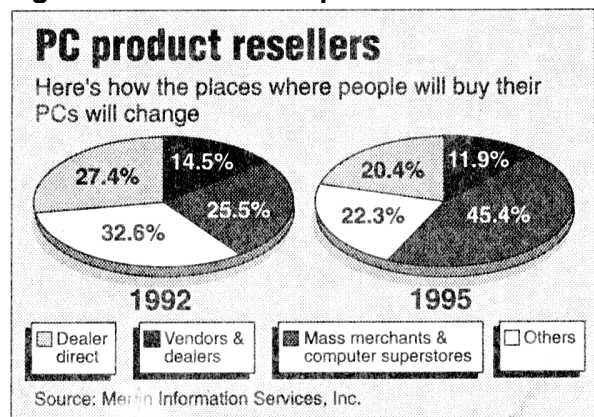
Figure 1. Bar Chart Representation

There many software programs available that construct such plots automatically. The categories are clearly distinct, and the legend containing the time reference is easily understood. The height of bars represents the data linearly. Bar charts, however, have a somewhat static appearance, and comparing the magnitude and direction of *changes* across categories requires considerable visual retention. The data-ink ratio, a measure of graphical excellence espoused by Tufte (1983), is somewhat low.

An alternative form of display, very popular in newspapers, is the pie chart. Figure 2 is the actual copy of how the data was originally presented.

Figure 2. Pie Chart Representation
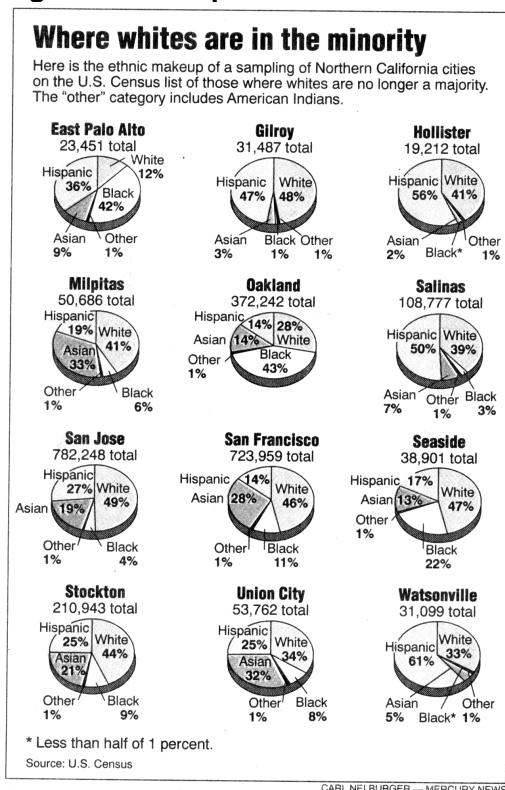
The pie chart has the sole advantage of showing how parts make up a whole, and many software packages provide procedures for generating such plots. However, the layout is visually demanding, requiring the viewer to constantly cross-reference and compare angular areas separated in space. One's eyes constantly scan back and forth over many regions to absorb and interpret the information. To comprehend changes, a high degree of visual retention of either object shapes or numbers is required. The data-ink ratio is very low.

In the view of an expert, Tufte (1983) states, "the only design worse than a pie chart is several of them...pie charts should never be used." I'd like to add that the only design worse than several pie charts is several pie charts with legends attached!

Yet pie charts are very often used. In an extreme example that appeared this year, the *San Jose Mercury News* presented the graphic reproduced below as Figure 3. Surprisingly, this collection of a dozen pie charts involves only a single time reference! No period-to-period comparisons are provided.
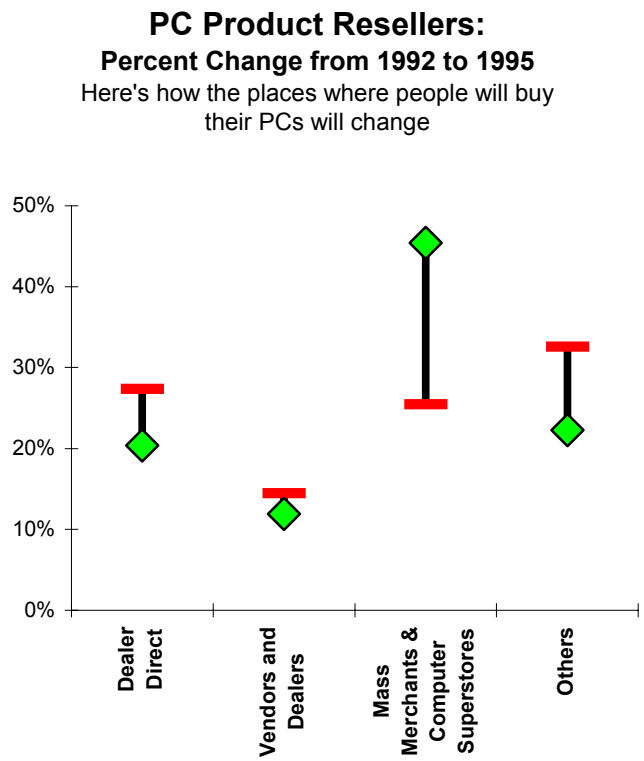
Is there a better way to display data across many categories, especially for representing comparative results? We seek a graphical form that's simpler, less tedious to view, and for which interpretation is obvious. I believe arrow charts are such a tool.

Similar to the bar chart, an arrow chart has an horizontal axis that identifies the categories, and the vertical axis gives the measurement scale. The distinctive feature is that an arrow is drawn for each category such that the base of the arrow starts at the numerical measure associated with the first time point, and the tip of the arrow ends at the measure of the second time point. Thus, the *direction* of change is indicated by the orientation of the arrow and the *magnitude* of change by its length. Interpretation is immediately obvious. The equivalent of an arrow chart can be constructed fairly easily in various software packages, such as Microsoft EXCEL. Figure 4 shows the Table 1 PC data set as an arrow chart in EXCEL.

Figure 4. Arrow Chart Representation of PC Resellers Data (EXCEL Format)

Figure 3. Multiple Pie Chart Illustration

PC Product Resellers:
Percent Change from 1992 to 1995
Here's how the places where people will buy their PCs will change

Further embellishments to arrow charts can be accomplished by labeling the changes, or the ends and tips of the arrows, enlarging the arrow sizes, using colors (e.g., red down, green up), and so on. If desired, cumulative differences can be represented by an additional arrow for a totals category in the same figure.

The advantages of the arrow charts are quick and easy interpretation, linear representation of values, and dynamic appearance of changes. The format is excellent for multiple comparisons, and there is a high data-ink ratio. Hopefully, future generations of software will incorporate arrow charts routines into the standard packages.

At AMD, arrow charts are provided to executives on a weekly basis showing quarter-to-quarter and year-to-year changes in bookings, billing, current backlog, and next quarter backlog. The information for the entire corporation is presented on one page! Each major category is then arrow-charted across the seven divisions, for the same periods, with one page for each division. In a few pages, the executives gain---in minutes---an accurate picture of the financial health and future prospects of the company. Previous reports required many pages of high density tables that took considerable time and effort to comprehend.

In conclusion, arrow charts provide a superior format for the display of multiple sources of comparative data. Arrow charts can successfully display quick summaries of many divergent pieces of information for executive awareness and decision making. Finally, arrow charts are easily constructed using readily available software tools for the PC.

Reference:

Tufte, Edward R., *The Visual Display of Quantitative Information*, 1983, Graphics Press, Cheshire, Connecticut