Improving Business Students’ Ability to Communicate Quantitative Information: A Tutorial Approach to Build Clarity and Objectivity into Reporting

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Final Report for  
Summer Semester 2004 IIG Report

Presented at Faculty Development Committee Seminar  
February 6, 2006
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Problem Statement

Every business executive uses numerical and statistical evidence to support decisions. Yet the way in which this data is presented dramatically affects how it will be interpreted and used. Overwhelmingly, business people rely on software packages such as PowerPoint in their presentations of such information. Increasingly, information architects, business communications specialists and even executives are criticizing the results for distracting our attentions, distorting the understanding, and the oversimplification of rich information (c.f., Thompson 2003). While some may see this as a relatively small problem, Edward Tufte (2003) and others argue that the inability to effectively convey the numerical and statistical information necessary to make good decisions contributed directly to the Challenger and Columbia shuttle disasters.

Business schools and universities recognize the need for strong communication skills and have used programs such as Writing Across the Curriculum to develop oral and written communication skills. In fact, the new RCB MBA program requires additional courses in business communication. However, these courses overwhelmingly focus on the verbal and oral communication and not the more technical communication of numbers through words and pictures.

While many courses and textbooks emphasize credible data analysis and interpretation, there is little training in the use of visual and verbal language to ensure the unambiguous communication of data. In a review of textbooks in marketing research shows at most 1-3 pages, mostly devoted to when to use different types of charts (i.e., bar charts, pie charts). Virtually no attention is provided to assuring that the data is presented to facilitate accurate communication to the receiver or reader. Given that most reports, even if presented orally, ultimately get distributed in print form (i.e., the slide deck), the attention to conveying numerical and statistical data becomes more important; the data must stand on its own since there is no one there to explain it.

Students must develop the ability to give their user complex information in clear, precise and effective forms. Integrity is about ensuring the objective portrayal of data. “Each part of a graphic generates visual expectations about its other parts and,…, these expectations often determine what the eye sees” (Tufte, 1983, p. 60). Thus all the choices in a graphical display (i.e., type of chart, choices of axes, scales, dimension) affect the interpretation. Much of what Tufte calls “chartjunk” (e.g., fills, colors, density) causes unintentional optical illusion or distortion. In addition, accurate interpretation of data requires a clear context-dependent portrayal. For example, the data must be presented “in comparison to” relevant, objective criteria, proportional to the numerical representation, and within the methodological context of the data generation/collection. Finally, understanding is enhanced through verbal language that matches the visual display and the numbers. Scipione (1995) found that there is tremendous variation in the perceived meaning of common verbal language for numbers, statistics and relationships. While some would argue that banning PowerPoint is the answer, the more realistic solution is to help students learn that “Only a GOOD picture is worth a thousand words” and that precision,
not entertainment value, is a more valuable career skill. This can be done by teaching them the principles of data integrity and graphical excellence.

Method

I completed a number of seminars and short courses, including “Presenting Data and Information” with Edward Tufte and “More Effective Graphs and Charts” by Lynd D. Bacon. Using expertise developed through these seminars and literature on creating effective graphical displays, I worked with James Poulakos, a designer with Instructional Technology Services to create two sets of audio-visual modules. The first module was an 11-minute video that was used in classes to demonstrate the principles of choosing effective graphics and the criteria for deciding among alternatives offered in standard software packages. A pdf handout was also created so students would have the principles in the video available for reference.

The second module, which was ultimately provided in three parts to facilitate streaming, demonstrated for students a step-by-step approach to graphic design in Excel. Specifically, it shared with students the typical language of graphical design programs (e.g., axis, tick marks), the means for changing various options (e.g., background colors, lines), and the principles that should guide their choices (e.g., reducing distracting elements, providing data values). The second module was designed so that students could control the delivery, allowing them to follow along and re-create the same graphics. Choosing the Right Charts and Graphs and three additional videos to help students use Excel to implement these principles. (Modules can be found at http://hollywood.gsu.edu/mkt/mktpse/Charts_n_Graphs/parts/parts-of-graph-part_1.mov).

The modules have been used in all Marketing Research (MK8200) and Marketing Intelligence (MK8210) classes since their creation in which research reports are required for term projects as well as other assignments. The modules, particularly the first one, were also used subsequently in Business Communications classes (BComm3950) taught by instructors including Carol White, Christine Heuring and Gillian Royes.

Implementation

To improve students’ skills in effectively portraying data in research reports, a set of exercises were created for students to demonstrate their current skills, critique their efforts and revise their efforts. Students were initially given an assignment to create charts or graphs appropriate to the course topics (see Appendix A and B). After completing the assignment, students are asked to rate their confidence in their skills to create effective portrayals of data. (See Appendix C for pre-assessment instrument.)

Students then watch the 11-minute video entitled Creating Effective Charts and Graphs (see Appendix D for handout showing content). Following this, students share their charts and graphs and critique their own efforts, identifying ways to improve them. They then complete the post-assessment survey.
Subsequently, students complete the second modules, replicating graphs in the module and thus demonstrating their competency with customizing default charts and graphs in programs like Excel. This includes eliminating chartjunk (e.g., unnecessary background colors, shading) and simplifying the presentation so the focus is on the data not the chart itself.

On the exam following these modules, students critique two charts, delineating the specific rules of good design and means for remedying them. The principles are reinforced in term projects and other assignments for the remainder of the semester.

**Assessment**

Paired t-tests were used to assess the pre-post self-assessment ratings of students. As shown in the table below, students ratings of their skills were statistically significantly higher in the post-surveys on all dimensions than in the pre-assessment.

<table>
<thead>
<tr>
<th>Individual Assessment (n=96)</th>
<th>Mean Post (5-point scale)</th>
<th>Sign. Of Paired T-tests</th>
<th>Increase in mean from Pretest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Currently vs. In future,...</td>
<td>I can choose appropriate statistics for the data</td>
<td>3.93</td>
<td>.00</td>
</tr>
<tr>
<td></td>
<td>I can explain the meaning of the statistics to the audience</td>
<td>3.73</td>
<td>.001</td>
</tr>
<tr>
<td></td>
<td>I know which type of chart or graph is appropriate for different types of data</td>
<td>4.24</td>
<td>.00</td>
</tr>
<tr>
<td></td>
<td>I can create a chart or graph that assures every reader will correctly interpret the data</td>
<td>4.03</td>
<td>.00</td>
</tr>
<tr>
<td></td>
<td>I can recognize elements of a chart or graph that may mislead a reader or audience</td>
<td>4.09</td>
<td>.00</td>
</tr>
<tr>
<td></td>
<td>I can create and customize a chart or graph (using software such as Excel or Powerpoint) that eliminates distracting or confusing elements.</td>
<td>4.14</td>
<td>.00</td>
</tr>
</tbody>
</table>
References


Appendix A
Marketing Research Assignment

Data Portrayal

Purpose: To create a short report that clearly presents data

Following are the data provided by researchers from a survey recently conducted.

1. Review the data. Use the data as is or transform it as you see fit.
2. Identify important/insightful points.
3. Create a short report in PowerPoint (same format used for your project) to management on the research. Using Excel or PowerPoint, create AT LEAST three charts or graphs to support the points you identified.
4. Be prepared to present in class.

Survey Results

A magazine for people interested in home-based businesses surveyed 350 customers. They asked them how helpful they found several articles in a recent issue. The question used a 1-4 scale where 1 = Didn't Read, 2 = Not Helpful, 3 = Somewhat Helpful, 4 = Very Helpful.

<table>
<thead>
<tr>
<th>Article Title</th>
<th>Didn’t Read</th>
<th>Not Helpful</th>
<th>Somewhat Helpful</th>
<th>Very Helpful</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial Tips for Getting a Loan</td>
<td>13</td>
<td>75</td>
<td>128</td>
<td>134</td>
<td>3.09</td>
</tr>
<tr>
<td>Sales and Marketing Tactics</td>
<td>22</td>
<td>61</td>
<td>109</td>
<td>158</td>
<td>3.15</td>
</tr>
<tr>
<td>Hottest New Business Ideas</td>
<td>84</td>
<td>38</td>
<td>137</td>
<td>91</td>
<td>2.67</td>
</tr>
<tr>
<td>Recognizing Scams</td>
<td>25</td>
<td>71</td>
<td>143</td>
<td>111</td>
<td>2.97</td>
</tr>
</tbody>
</table>
Appendix B
Marketing Intelligence Assignment

Data Portrayal – Sales Data

Using the information provided below, create a short report that uses charts or graphs (i.e., pictures).

1. Review the data. Use the data as is or transform it as you see fit.
2. Identify important/insightful points that management should know.
3. Create a short report in PowerPoint (same format used for your project) to management on the research. Using Excel or PowerPoint, create AT LEAST three charts or graphs to convey the points you identified.
4. Be prepared to present in class and discuss the choices that you made.

Keep in mind that the reader should be able to understand the report without someone to explain or interpret.

A new district for an insurance broker is opened. Following is the number of sales for three of their products.

<table>
<thead>
<tr>
<th></th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Product A</td>
</tr>
<tr>
<td>August</td>
<td>88</td>
</tr>
<tr>
<td>September</td>
<td>94</td>
</tr>
<tr>
<td>October</td>
<td>103</td>
</tr>
<tr>
<td>November</td>
<td>113</td>
</tr>
<tr>
<td>December</td>
<td>122</td>
</tr>
<tr>
<td></td>
<td>520</td>
</tr>
</tbody>
</table>
**Appendix C**

**Pre-assessment Instrument:**

Please take a moment to think about your experience and expertise in creating charts, graphs or other displays of data.

Assume that you are provided data about customer responses to marketing offers. You need to prepare a report to share the results with others. Assume that the report will be read by others and they must all come away with the same understanding of the results.

Please rate your own skills on the following tasks:

<table>
<thead>
<tr>
<th>Task</th>
<th>Strongly Agree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I can choose appropriate statistics for the data</td>
<td>☐, ☐, ☐, ☐, ☐,</td>
<td></td>
</tr>
<tr>
<td>I can explain the meaning of the statistics to the audience</td>
<td>☐, ☐, ☐, ☐, ☐,</td>
<td></td>
</tr>
<tr>
<td>I know which type of chart or graph is appropriate for different</td>
<td>☐, ☐, ☐, ☐, ☐,</td>
<td></td>
</tr>
<tr>
<td>types of data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can create a chart or graph that assures every reader will</td>
<td>☐, ☐, ☐, ☐, ☐,</td>
<td></td>
</tr>
<tr>
<td>correctly interpret the data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can recognize elements of a chart or graph that may mislead</td>
<td>☐, ☐, ☐, ☐, ☐,</td>
<td></td>
</tr>
<tr>
<td>a reader or audience</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can create and customize a chart or graph (using software such as</td>
<td>☐, ☐, ☐, ☐, ☐,</td>
<td></td>
</tr>
<tr>
<td>Excel or Powerpoint) that eliminates distracting or confusing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>elements.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Post-assessment Instrument:**

Now thinking about the principles presented in the module, exercise, and/or handout. In the future, how would you rate your skills at the following?

<table>
<thead>
<tr>
<th>Task</th>
<th>Strongly Agree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I will be better able to choose appropriate statistics for the data</td>
<td>☐, ☐, ☐, ☐, ☐,</td>
<td></td>
</tr>
<tr>
<td>I will be better able to explain the meaning of the statistics to the audience</td>
<td>☐, ☐, ☐, ☐, ☐,</td>
<td></td>
</tr>
<tr>
<td>I will be better at choosing the type of chart or graph for different types of data</td>
<td>☐, ☐, ☐, ☐, ☐,</td>
<td></td>
</tr>
<tr>
<td>I will be better able to create a chart or graph that assures every reader will correctly interpret the data</td>
<td>☐, ☐, ☐, ☐, ☐,</td>
<td></td>
</tr>
<tr>
<td>I will be better able to recognize elements of a chart or graph that may mislead a reader or audience</td>
<td>☐, ☐, ☐, ☐, ☐,</td>
<td></td>
</tr>
<tr>
<td>I will be better able to create and customize a chart or graph (using software such as Excel or Powerpoint) that eliminates distracting or confusing elements.</td>
<td>☐, ☐, ☐, ☐, ☐,</td>
<td></td>
</tr>
</tbody>
</table>
Appendix D
Handout for Creating Effective Charts and Graphs
Choose the right graph or chart style for the task you want your audience to accomplish.

See how something changes over time, such as income …

Show how one change is related to another, such as fuel prices and food costs...

Show cause and effect ...

… or show that there’s no causal relationship at all ...

Compare the parts of a whole, such as … how many are heavy users, use occasionally, or never use at all?

Rank items in a particular order … which is the highest, or … how does our market share compare?

See frequency distribution: how items in a group are clustered or spread out, such as:

The age distribution of our clients;

Error rates in shipping concentrated around certain times of year…

The main thing you’ve got to ask yourself is: what am I asking my audience to do with this data?

There are 3 basic types of chart or graph

Believe it or not, there are really only 3 basic types of chart or graph. All the rest are just variations of these:

The pie chart, , the bar chart , and the line chart, .

Bar charts may be either horizontal or vertical – these vertical bar charts are sometimes referred to as column charts.

A line chart can be created by connecting the tops of the bar chart.

A dot chart is really just an incomplete line chart.

Rather than think about the ways we can bring variety to our presentation, let’s look at what each type of chart is best at representing.

The line chart is very familiar, so we’ll tackle that one first.

### Line Charts

A dot, or scatter-plot, chart is really just an incomplete line chart. We either have some dots and we connect the lines, … or, really, we’re asking our audience to do it.

The only significant difference between a scatter-plot graph and a dot graph is that the dots are so scattered, a single line wouldn’t make a fair representation …. So, for those, we can, and should, leave out the lines.

In other cases, shouldn’t we just go ahead and draw the lines?

Line charts are best for showing pattern in the dots and changes over time. The line chart naturally makes us look from left to right, just as we do when reading.

A line chart can be used for showing how one change is related to another.

If you need to show more than 3 relations, don’t pile up more lines.
Instead of giving your audience one mass of ‘tangled wires’, or a complex code …
… give them separate charts. We can make small multiples of the chart, and graph our various changes against one, important line that we re-use, from chart to chart.

So maybe you’re asking yourself: why are small multiples so great? They take up more space and it takes me longer to make ‘em!

They’re better because they make your points more clearly. Your reader does not have to untangle all those lines; they save your reader the effort of moving back and forth from the legend to the actual graphic; once she understands how to read the first graph, she can quickly absorb the rest of them, so you may not even need a large graph.

In some cases, you get a chance to repeat your message. The repetition reinforces your message.

Maybe you ask, ‘what if I want my audience to compare more than 3 variables as they change over time?’

Since the goal is to make comparisons, giving them their own graphs will generally be more clear.

If you must include 3 or more lines, keep the whole chart visually simple. If no lines cross, you can do it like this… … but if they do cross, use small multiples instead.

Line graphs with crisscrossed lines, with different kinds of dotted and dashed lines, or with color codes are not effective ways to communicate your message. Avoid using those.

In line charts that plot a change over time, time should always move from left to right. Don’t put time on the vertical axis. In fact, your graphs should generally be horizontal, not vertical, in their overall shape.

Your audience reads left to right, and they are used to looking at horizons and horizontal charts.

More importantly, set your own axes – don’t let some software designer do it for you. Whether you intend it or not, your message can change. You want the picture to accurately show the data – whether the news is good or bad. Otherwise your audience will become suspicious: ‘Hmm, why are they trying to trick me by making the lines look steeper and more dramatic?’

Or you’ll lead your audience to poor decisions with misleading data. See how a change in axes changes the message of the chart?

Which one is right? Only you can decide based on objectively examining the data and determining the right message.

These same rules are true for bar charts. We’ll use the term bar charts to refer to both horizontal and vertical versions – again, the latter are sometimes called column charts.

In fact, many bar charts might be thought of as blocky line charts if, for example, they show changes over time.

Rather than showing change over time, bar charts are best for categorical data – that is, items that don’t belong in any particular order, such as when you want to show your audience, for example, how our sales compare with their sales...

How does our state’s traffic accident count compare with other states?

Which nation had the highest Gross National Product last year?

What’s the total cost of ownership of this product vs. other products?

As we saw, bar charts can be vertical or horizontal. A couple of cases where you should use one instead of the other would be:

• if the chart is really showing a time series [in which case, use a vertical bar chart]

• if you’re not talking about changes over time, and your labels don’t fit under the columns [in which case, use a horizontal chart].
Sometimes it just doesn’t matter whether you use vertical or horizontal bars, but it’s important to remain consistent. Don’t mix up charts just for the sake of variety. You’re not here to entertain. You want your audience to be able to read your graphs clearly and easily.

Besides comparison of items, bar charts can also be used for comparing frequency distributions.

The key word here is ‘comparing’… if you want to compare two or more frequency distributions, you can use bar or column charts that share a common baseline.

It’s easier for us to compare the various parts when they are in adjacent bar charts, rather than adjacent pie charts. We can even connect lines between the bars, to help mark the differences … that’s something we can’t really do with pies.

Bar charts can also be used instead of pie charts. This works really well when you are asking your audience to compare two or more different values.

Speaking of pies – pie charts may be one of the most popular. But they are quite often bad choices! Here’s why:

-- humans can’t read and compare the area of an object like we can with a length.

In fact, humans are very good at estimating fractions of lines… … but research shows we are not so good at estimating slices of pies. We can reliably only recognize halves and quarters. Even thirds can give us a hard time.

Pie graphs are really only good at one thing: showing the parts of a single whole. If you want to compare lots of wholes, with all their parts …

… you could try small multiples, but let’s face it, it’s easier to compare bar charts than pies. We can compare the heights of shaded bars far more easily, left to right, than we can the sizes and shapes of a bunch of little pie slices.

If you really want some pie, save it for when you only want to compare the pieces within a single whole, and when there are only a few categories.

If you’re not talking about percentages of a whole or fractions of something, then stay away from pies.

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Part of a series on Charts & Graphs by James Poulakos, UETS Digital Media Group, with Dr. Pam Ellen, Department of Marketing, Robinson College of Business, Georgia State University

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