Chart Smart:
Design Graphs, Maps, and Tables for Effective Communication

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Abstract and Introduction

The time and attention of a communication recipient are valuable resources.

Computers and software make it easy to quickly produce a stack of graphs, maps, and tables, replete with clip art and special effects, but cannot guarantee their communication effectiveness. This paper on communication with SAS* and SAS/GRAPH* explains how to create powerful presentation materials, and visual reports digestible at a glance.

Familiarity with SAS and SAS/GRAPH is assumed. Most ideas are software-independent. No code is presented. Emphasis is on design principles and illustrations. However, due to the page-count limit for publication, only a few illustrations can be included.

On Communication

"Put it before them--
briefly . . . so they will read it,
clearly . . . so they will appreciate it,
picturesquely . . . so they will remember it,
and, above all,
accurately . . . so they will be guided by its light."

<div align="right">Joseph Pulitzer</div>

"Simplicity has power."

<div align="right">LeRB</div>

Need for Care

- Software & hardware = power tools
- Potentially lots of sub-optimal results quickly

Accept Software Defaults?

Only if you're undemanding (Figure 2)

Use Options?

- Customize for elegant graphs (Figure 3)

  powerful presentation materials--
  easily interpreted

  reports digestible at a glance

- Suppress inessential graphic elements
- Design & implement standard formats

Consistency _

Define a style, and stick to it

- Titles, footnotes, notes
- Font choices & sizes
- Symbols, line types, etc.

Standard Formats

- Consistency breeds/speeds comprehension
- Viewer needn't "recalibrate" page-to-page
- Productivity--preparer spared over-choice:

  less decision-making, fewer iterations

- Best implemented with macros

Maximize Data, Not Paper-marking

- Software defaults biased to traditional props
- Turning off props = more work, but--
- Restraint in elaboration = less work

Special Effects

- Good design & interesting data
  can stand on their own

  Productivity & communication
  are the real objectives

- Drop the drop-shadow
- Block out blocks
- Adumbrate the shaded background
- *Do use* PROC GREPLAY & TEMPLATES
  to create composites (e.g., Figure 8)

2 Is Enough

- 3D pie charts--always distortion
- 3D bar charts--needless complexity
- 3D maps--
  SURFACE, PRISM, BLOCK cute, but
  poor interpretability (even hidden parts)
- *Exception:* 3 variables

Text

- Always use black--it's the most readable
  Emphasize with *italics* (or **bold**), not color
- SAS variable name an unacceptable label

- Unless compelling counter-need,
  use mixed upper and lower case

  Mixed case is the business communication standard, and easier to read; all upper case is a hold-over from primitive computer printing.

- Keep it brief

  Focus viewer attention with sparse text

Decimal Precision

- Not doing science--usually suppress decimals
  (Footnote any imperfect sum of rounded values)

Font Choices

- At most, use one or two type styles

- Prefer hardware characters, *if available*

- Fancy software font: maybe title, footnotes

- Maybe italic form (if available) of basic font,
  for emphasis

Font Sizes

- At most, use three

- Titles (usually make all same size),
  maybe H > 1

- Body text, usually H=1
  (unless need dense tick-mark text)

- Footnotes smaller, only if downplayed

Axes

- Turn off axis lines (they tell nothing)

- Turn off tick marks

- If not turning off axis labels, supply your own

- Label (invisible) tick marks sparingly

Axis Ranges

- De-accentuate fluctuations--

  Start axis at zero, *not* the SAS/GRAPH default
  Prevent needless anxiety, questions

- For percents,
  use range 0-100 (& label the ends)

  Bar length = visual percent
  Absolute maximum is natural choice

- For trend chart issued monthly,
  use fixed number of months

Color vs. Black-and-White

- No response levels or categories--black & white

- Few levels or categories--grey shades

- Many levels or categories--color

Color Feasibility

- So far, no color device combines

  high speed
  high quality
  fuss-free & reliable operation
  low price
  plain paper

- Reject any device with fewer than 8 colors

In Praise of Drabness

Compared with color, black-and-white hardcopy is

faster;
cheaper;
more reliable;
easier to use--
  simpler equipment,
  no agonizing over color strategy;
more copyable--
  there are more, cheaper, faster BW copiers

Usually Omit Area Fill

- Beneath line(s)--ALWAYS

- In pie slices, unless color presentation

- On simple bar charts--
  but maybe light grey,
  especially if bars close together

- On maps, unless for response levels

Area Fill Types

- To carry information,
  use solid colors or grey shades

- *In desperation only,*
  use parallel lines or cross-hatching

- On maps, *no* parallel lines or cross-hatching

Symbols on Plot Lines

- Use V=NONE, if possible

  Can use W= to distinguish multi-line,
  rather than V=, if only two lines

- For point detection, not just trend, recommend:

  V=DOT (this is a BIG dot)
  V=CIRCLE
  V=- (traditional, circle around small dot)

Pies vs. Bars vs. Lines

SAS/GRAPH pie charts tend to lose the SLICE, VALUE, and PERCENT text if there are too many slices, especially for the small ones. However, the Pac-Man Pie Chart (Figure 1) is an excellent use of the pie chart, and never has that problem. If the small slice needs detail provided, that can be put (with the big slice as well) in a table.

The Enhanced Horizontal Bar Chart (Figure 4) is a foolproof, better alternative to the over-used pie chart. It provides image and detail optimally combined: category name; percent of whole; graphic depiction of relative size; and value (ranked). It always works, even if the pie chart fails--when text for small pie slices does not print.

Besides comparing percents of the whole in this way, bar charts can, of course, simply compare magnitudes, or can display trends or changes.

Line charts are for trends. If one wishes to annotate data points, a simple bar chart is better than a single-line chart--there is no chance of a value being obscured by a line. If a multi-line chart has too much crisscrossing, a side-by-side bar chart works better.

Order of Pie Slices

● Default--by slice name

● More useful--by decreasing size:
Release 6.07, DESCENDING option;
Before that, achieve via MIDPOINTS=

Pie Labels

● Specify NOHEADING

● All OUTSIDE

● *Do not* match color of label to that of slice--e.g., yellow text on white paper is impossible to read

● SAS/GRAPH-computed PERCENT always NN.NN%: Can be circumvented--see paper "Pie Charts and Bar Charts" (reference given below)

● SAS/GRAPH appends .0 to integer VALUEs: Suppress with FORMAT statement

Vertical Bar Charts

● Put values at ends of *simple* vertical bars

● If complex, use side-by-side, not stacked, bars

● For complex vertical bar chart, use PROC GREPLAY with a template to put the bar chart above, and a table below for detail look-up

Graphs Versus Tables

A good business use of a chart is to display visually the relative size of measurements, and to supply detail at the same time. Presentations or reports that integrate image (i.e., impact) and numbers (i.e., precision) are memorable, quickly and easily comprehended, and both influencing and reliable for decision-making.

Except for the numbers at the right margin of horizontal bar chart, or the numbers supplied at the ends of bars on a simple vertical bar chart, the best solution is usually a companion table for the graph.

For a simple trend line, you can *make the graph talk* with "Sparse Annotation" (see Figures 6 and 7).

The best answer to the question of "graph versus table" is often "graph *and* table". See Figure 8.

"Let Part Stand for the Whole"

I once read the above recommendation for effective communication. The point is that often, if not almost always, the *essence* or the *most significant* is enough. And, if more turns out to truly be desired, it can be supplied on demand, rather than as routine.

Implementations of this precept include:

Exception Report
Summary Report
Ranking Report (Figure 5)
Pac-Man Pie Chart (Figure 1)

Sequencing the Information Presentation

● First, the Exception Report

To monitor actual measurements versus goals or thresholds, any exceptions must be on Page 1 of a hardcopy report, or selectable as Option 1 on the main menu for an online report. All exceptions should be on one page, even if the measurements are for totally unrelated items.

● Second, the Summary Report

If the report includes trend charts and/or historical tables, there should be a one-page summary to show all the current report-month (or report-week or report-day) critical values.

● Then, everything else.

Sequencing Information in a Graph or Table

● To provide an all-encompassing look-up tool for a large set of categories, order the graph or table entries alphabetically by category name.

● To provide a tool for rapid identification and assessment of categories of significance, order the graph or table entries by decreasing value of the measurement of interest.

Ranking Report (Figure 5)

● Focus attention on high-impact categories

● Often the high-ranking categories that can be fit on one page account for 80-99% of the total of the measurement of interest, even if the full list of categories would run to several pages.

● Also, limit the list:

■ Show only the Top NN--e.g., Top 10

■ Show only values above a minimum cut-off

The Enhanced Horizontal Bar Chart (Figure 4), though it includes all the values, is a *graphic* ranking report.
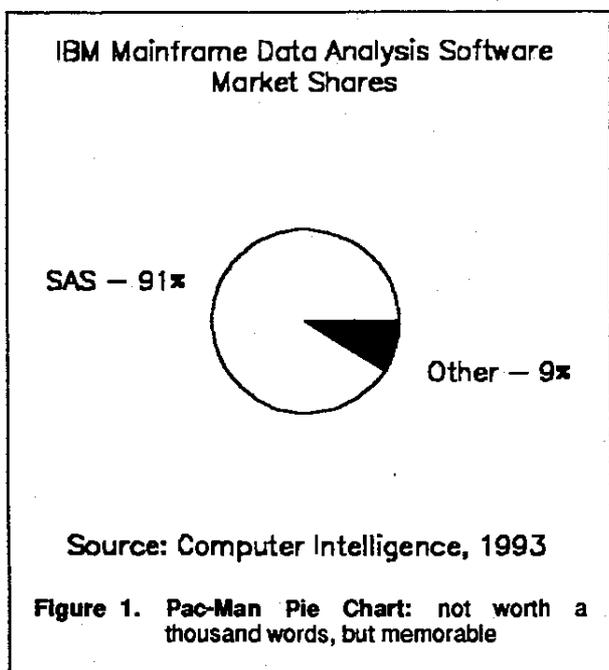
Graphic Formatting for Tabular Output

One can use a graphic "format" to display a tabular listing. Then, PROC GREPLAY can be used (as in case of Figure 8) to print a table on the same page as a graph. Also, such tables can be packaged with graphs (even on separate pages) in the same report with a uniform style for graphs and tables. Style includes, e.g., the choice and size of font(s), and the size of titles and footnotes. This is accomplished by running PROC PRINT, PROC TABULATE, or whatever, in conjunction with PROC PRINTTO, and then using PROC GPRINT.

I Call It the Pac-Man Pie Chart (Figure 1)

Even if not "worth a thousand words",

● A picture is more memorable

● Images stick, after numbers are forgotten--images, added to text, have been found to improve, e.g., effectiveness of fundraising and memory of the request. (Such images were thematic symbols, not photographs designed to evoke an emotional response.)

IBM Mainframe Data Analysis Software Market Shares

SAS — 91%

Other — 9%

Source: Computer Intelligence, 1993

Figure 1. Pac-Man Pie Chart: not worth a thousand words, but memorable

Statistical Maps

Two important communication problems in design and construction of statistical maps--how to non-arbitrarily autoselect response levels for a choropleth map, and how to create white space (i.e., "blanking") inside area-filled annotated geographic areas for enhanced readability--are solved in "Most Effective Use of PROC GMAP: Solutions for Professional-grade Statistical Mapping", a paper by Steven J. Subichin and me, elsewhere in these *Proceedings*. To see the value of blanking, compare Figures 9 and 10 below.

Related Papers By the Same Author

SAS code for the Enhanced Horizontal Bar Chart (Figure 4) and the Top NN List (Figure 5) is provided in "Software Intelligence: Applications That Customize Themselves", on pages 114-122 of *Proceedings of the Eighteenth Annual SAS Users Group International Conference*, SAS Institute Inc. (Cary, N.C.), 1993.

For the SAS code for Sparse Annotation, or for how to save resources (computer time, computer memory, print/plot time, etc.), see "Effective and Efficient Use of SAS/GRAPH Software".

For trend charts (as in Figure 3), see "Intelligent Production Graphic Reporting Applications".

For pies and bars, see "Pie Charts and Bar Charts: Getting Their Best out of SAS/GRAPH Software".

The last three papers cited are on pages 505-514, pages 183-189, and pages 264-273, respectively, of *Proceedings of the Seventeenth Annual SAS Users Group International Conference*, SAS Institute Inc. (Cary, N.C.), 1992.

Notices

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Demand, in Percent of Capacity

By Month, January 1989 to August 1991

MEASURE

100 —

90 —

80 —

70 —

60 —

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8 8 8 8 8 8 8 8 8 8 8 8 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9
9 9 9 9 9 9 9 9 9 9 9 9 9 0 0 0 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1
0 0 0 0 0 0 0 0 0 1 1 1 0 0 0 0 0 0 0 0 0 1 1 1 0 0 0 0 0 0 0 0
1 2 3 4 5 6 7 8 9 0 1 2 1 2 3 4 5 6 7 8 9 0 1 2 1 2 3 4 5 6 7 8
```

YYMM

90% is threshold for considering capacity increase

Figure 2. Trend Line Using SAS/GRAPH Defaults

Demand, in Percent of Capacity
By Month, January 1989 to August 1991
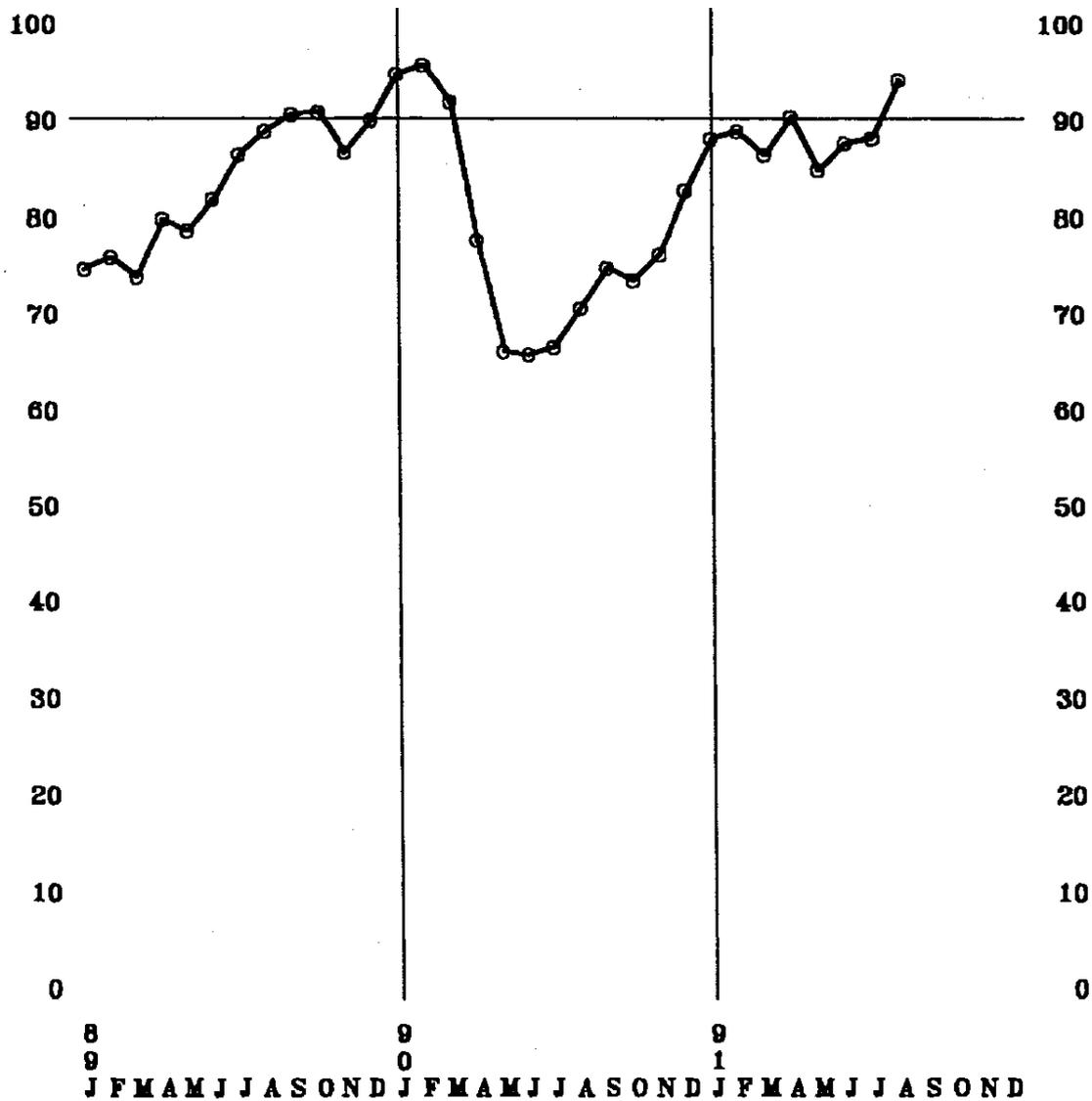
90% is threshold for considering capacity increase

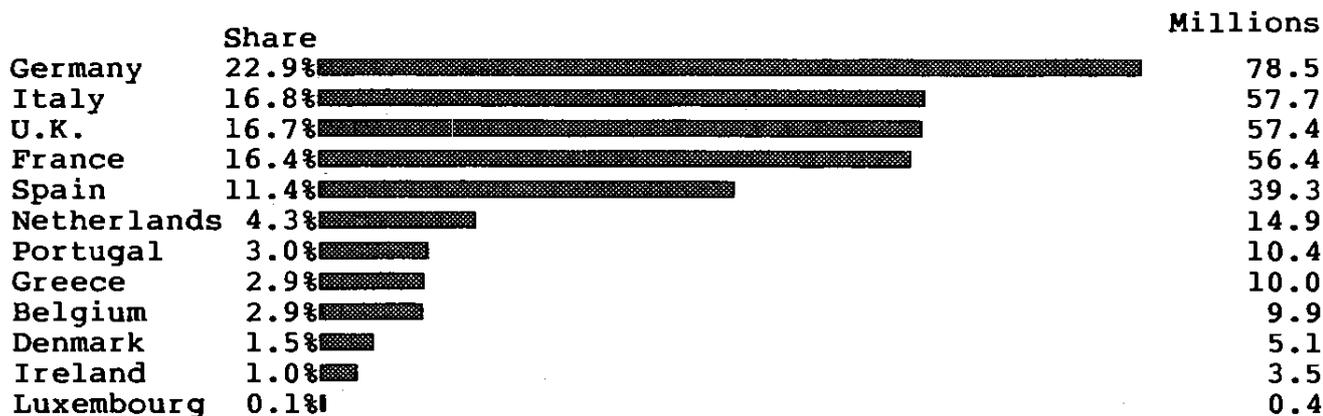Figure 3. Custom Trend Line, Using Macro-based Standard Format
_See "Intelligent Production Graphic Reporting Applications"

1990 Population in the European Community, By Country

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                Share                                                    Millions
Germany      22.9%███████████████████████████████████████████████████      78.5
Italy        16.8%█████████████████████████████████████████                57.7
U.K.         16.7%████████████████████████████████████████                 57.4
France       16.4%███████████████████████████████████████                  56.4
Spain        11.4%███████████████████████████                              39.3
Netherlands   4.3%███████████                                              14.9
Portugal      3.0%███████                                                  10.4
Greece        2.9%███████                                                  10.0
Belgium       2.9%███████                                                   9.9
Denmark       1.5%████                                                      5.1
Ireland       1.0%███                                                       3.5
Luxembourg    0.1%                                                          0.4
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Total = 343.5

Data Source: "The World Factbook 1990"


Figure 4. Bessler's Enhanced Horizontal Bar Chart

Top 10 Test SAS PROCs Used, 92-08-17 to 92-12-30

This list accounts for 92.5% of the total

Rank	PROC	Count
1	DATASTEP	19,877
2	SORT	6,392
3	REG	4,716
4	DATASETS	2,963
5	CONTENTS	2,877
6	PRINT	2,690
7	MEANS	1,680
8	SUMMARY	1,467
9	FREQ	1,101
10	GPLOT	1,048
		======
		44,811

Figure 5. Ranking Report—Top 10 List

A Quarter Century of Thirst

Annual U. S. Beer Consumption, in Gallons per Capita

Peak in
1981 at

24.6

15.9

0

1964   1969   1974   1979   1984   1989

23.3
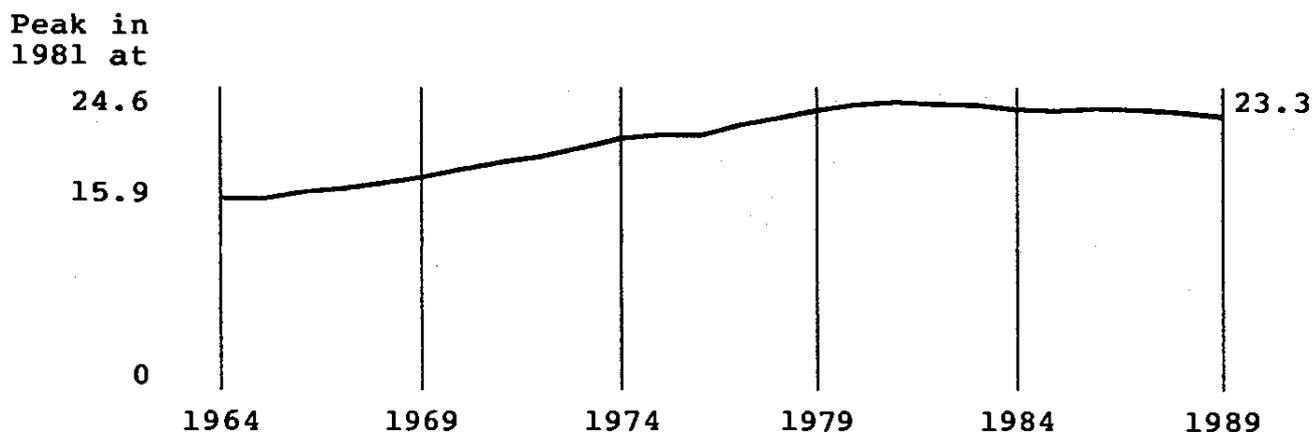
Gallonage: John C. Maxwell, Jr., Wheat First Securities
Reported in: "Beverage Industry", February 1990

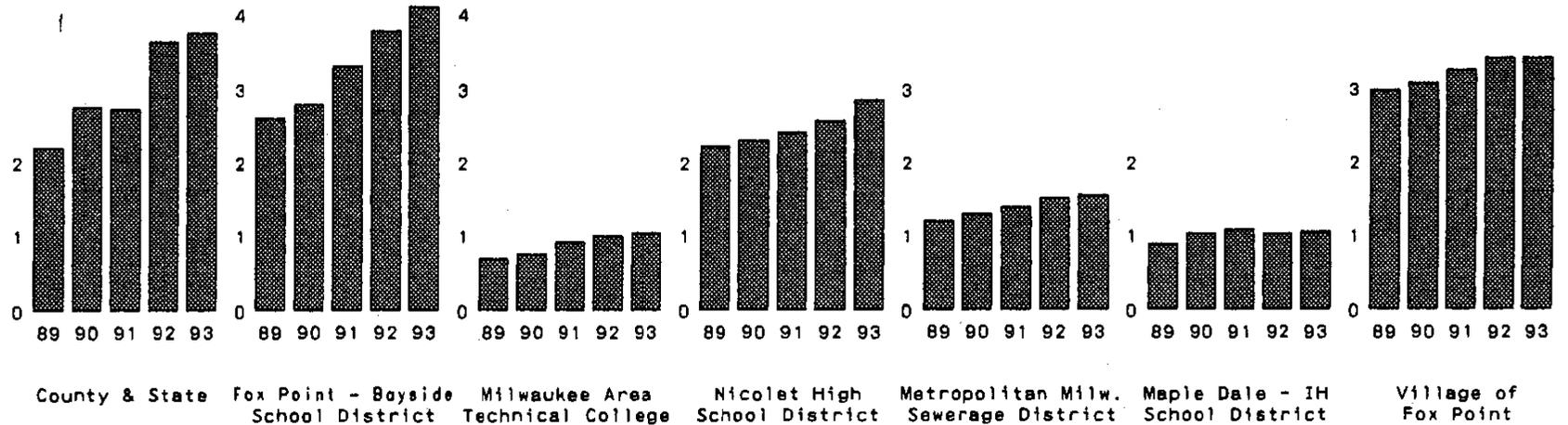Figure 6. Sparse Annotation, End-points and Maximum Only

Production of Miller Lite - 1977 to 1990

Millions of Barrels

20.3

16.3

7.5

0

1977   1981   1990
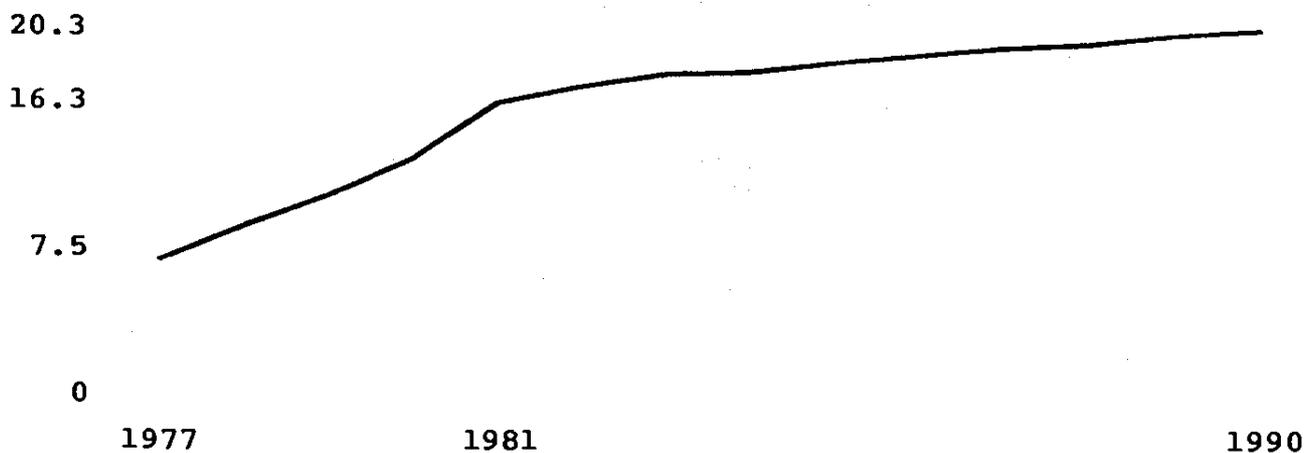
Data Source: "Beverage Industry"

Figure 7. Sparse Annotation, End-points and Special-Interest Point Only

704

Trends in Property Tax Levies (Millions of Dollars) in Fox Point

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| County & State | Fox Point - Bayside School District | Milwaukee Area Technical College | Nicolet High School District | Metropolitan Milw. Sewerage District | Maple Dale - IH School District | Village of Fox Point |

Growth and Amount of Property Tax Levies in Fox Point

Taxing Unit of Government	This Year's Increase	Increase Since 1989	This Year's Tax Levy
Nicolet High School District	+11.5%	+29%	$2,841,432
Fox Point - Bayside School District	+8.6%	+58%	$4,091,652
Milwaukee Area Technical College	+3.6%	+51%	$1,025,940
Milwaukee County & State of Wisconsin	+3.1%	+71%	$3,738,185
Milwaukee Metropolitan Sewerage District	+2.4%	+29%	$1,534,529
Maple Dale - Indian Hills School District	+1.9%	+19%	$1,035,738
Village of Fox Point	+0.0%	+14%	$3,396,151

For the five-year period, ability to pay (i.e., personal income) in the Milwaukee metropolitan area grew only 22%.

Figure 8. Composite Chart

Figure 9. Home States of SUGI 18 Attendees – State Codes & Counts Annotated Without Blanking
Some States Unreadable

Very Low   Below Median   Above Median   Very High
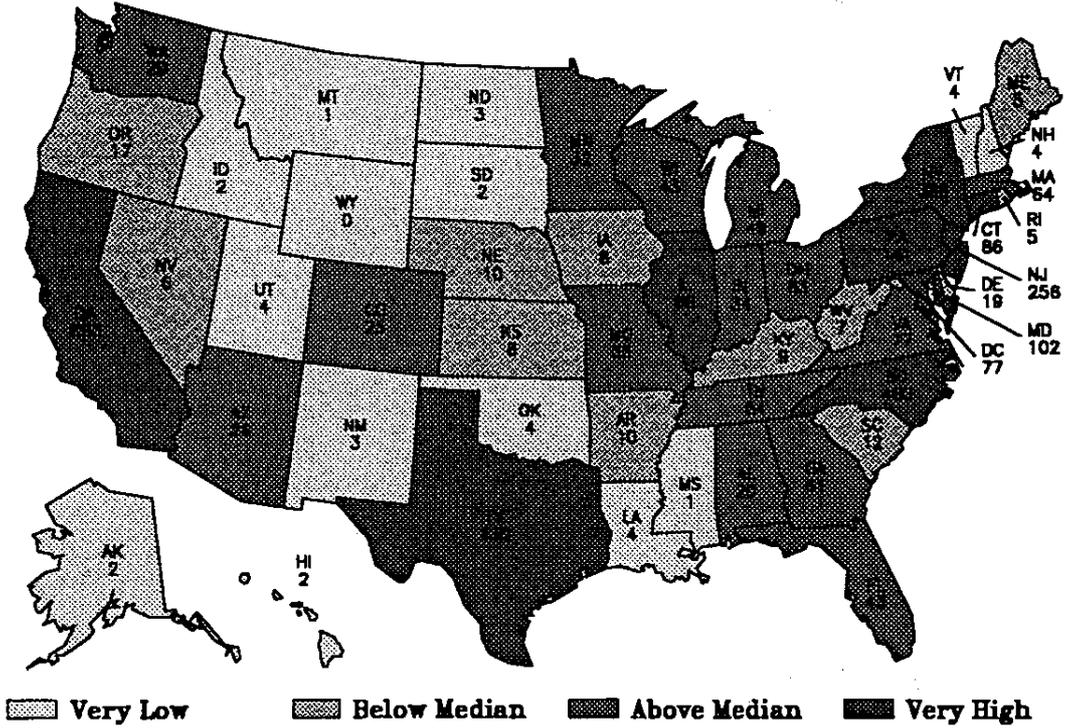
Figure 10. Home States of SUGI 18 Attendees – State Codes & Counts Annotated With Blanking
All States Readable

Very Low   Below Median   Above Median   Very High