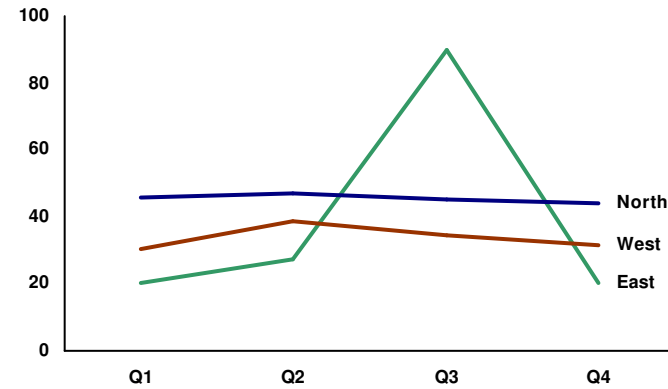
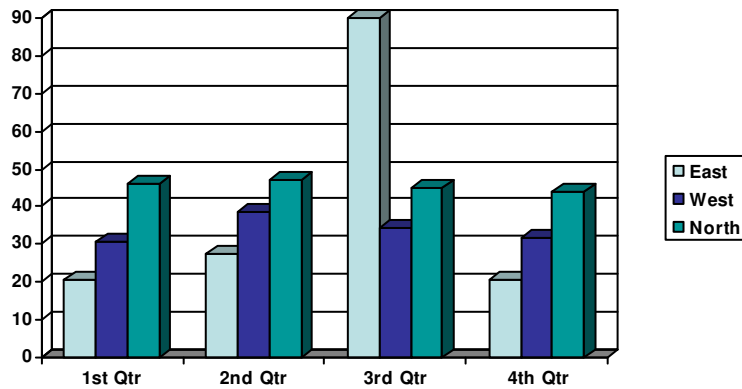


Communicating Clearly with Charts and Graphs



OFM 2007 Fall Forum
Tying it all together
Sept. 18, 2007 3:30 – 5 pm

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Communicating clearly with charts and graphs – Learning objectives & crib sheet

Learning objectives:

1. **Basic communications model** – The communications model can help define what clear communication means for communicating numbers with charts and graphs.
2. **Focus on users and the message** by choosing the right type of graph for the data
3. **Minimize noise** by eliminating distracting clutter in graphs
4. **Practice creating and editing charts**
5. **Share additional resources and answer questions**

Main points:

Sender - Message - Medium - Receiver
Feedback - Environment - Noise

Main user question: "Compared to what?"

- Line graphs = change over time
- Bar charts = differences among categories
- Pie charts = "parts of the whole", percentages

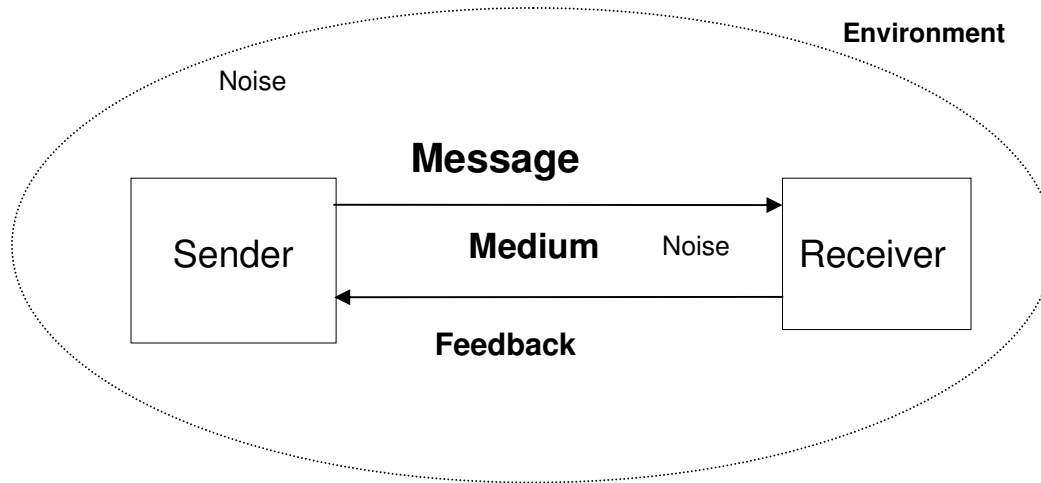
What is noise? Any little thing that distracts users from focusing on the message.

- 3-D effects
- Legend
- Background color
- Border
- Grid lines
- Tick marks
- Excess zeros, decimal places, words and letters

Right-Mouse-Button click, and pick "Format"

Part I. A. Basic communications model

Communications is a system. Any communication can be analyzed by describing the main parts of the system:



- A **sender** who has something they want to communicate
- The **message** itself
- A **medium** that carries the message
- A **receiver** – the person to whom you’re communicating
- **Feedback** – “Uh-huh”, “OMG!”, “What do you mean?”
- The **environment** in which communication takes place
- **Noise** – unintended distractions from the channel or the environment

Technical communication models include other elements (coder and decoder, filters, etc.)

The goal of communication is that the **receiver gets the message that the sender intended.**

Applying this to charts and graphics:

- Think of the user (i.e. the receiver) and what they want to know
- Choose the right type of chart for the data and message
- Reduce noise to improve the odds that the receiver can focus on the message

References:

For a thorough discussion of communication model, <http://www.cultsock.ndirect.co.uk/MUHome/cshtml/introductory/sw.html#pnoise>

Part I. > **B. Communicating with numbers**

Numbers tell certain types of stories

- How many things are there?
- How often do things happen?
- What type or degree of change has happened?
- Is change normal or unpredictable?
- Is change likely to continue in the future (i.e. a trend)?

When we use words to tell stories, we organize them in certain ways:

- sentences
- paragraphs

In the same way, to get numbers to tell stories, we have to organize them in certain ways.

- Tables are the first main tool for organizing numbers
- In a table, we put numbers in rows and columns

Every chart starts with a table of data, usually in a spreadsheet.

Whether to put data in rows or columns is up to you:

- Brian Willett likes dates in columns, going across the page
- I like dates in rows, going down the page
- We both produce similar graphs.

Example of a data table

Biennium	Period	Actual	Target
2003-05	Q1	59	58
	Q2	135	144
	Q3	174	210
	Q4	180	150
	Q5	117	58
	Q6	86	144
	Q7	188	210
	Q8	210	162
2005-07	Q1	122	119
	Q2	79	108
	Q3	169	162
	Q4	157	151
	Q5	62	62
	Q6	105	121
	Q7		160
	Q8		197

Source: Exercise 1 - DNR volume of timber sold

Part II. Focus on the users and the message > A. What makes an effective chart or graph?

A. What makes an effective chart or graph?

Graphic communication has the same goal as written or verbal communication:

Focus the user on the message, with minimal “noise” to distract them.

A good design is invisible.

Good charts lead to good conversations, clear understanding, better decisions.

Effective graphics:

- Are readily understood by the reader
- Are relevant to the world we live in
- Are timely
- Are formatted with a sense of balance, proportion, and clarity of design
- Have integrity (data/analysis, cite references, are signed)
- And answer some predictable, fundamental questions, the most important of which is . . .

Remember: Your reader is an intelligent, thoughtful person just like you. Make your charts easy to read and understand, but don't “dumb down” the information. (Tufte)

“Compared to what?”

References: Handout 2, Barbara Felver, “*Communicating effectively with graphics*”, <http://www.digitalarchives.wa.gov/governorlocke/improve/quality/tools/bfelver.htm>.

Part II. Focus on the users and the message > **B. Types of comparisons**

Graphic data acquires meaning when it has context.

Context can come from comparison among . . .

- **Categories** of things
- **Time** periods
- **Parts of the whole**

Other types of comparisons

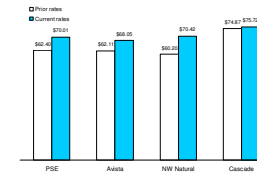
- Comparisons in space or geography
- How does it work?

Part II. Choosing the right chart > Types of comparisons > **C. Right chart for the each type of comparison**

Each type of comparison has a type of graphic best suited to showing it:

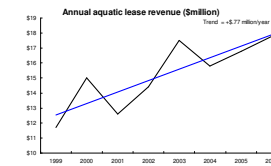
Category comparisons

Bar charts
Column charts



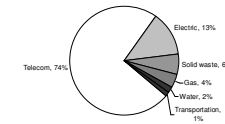
Change over time

Line charts
(run charts)



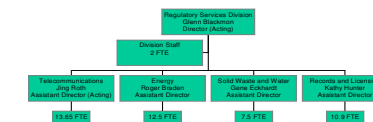
Parts of the whole - percentages

Pie charts



How does it work

Flow charts
org charts
diagrams



Spatial relations

Maps

Face of customer

Photographs

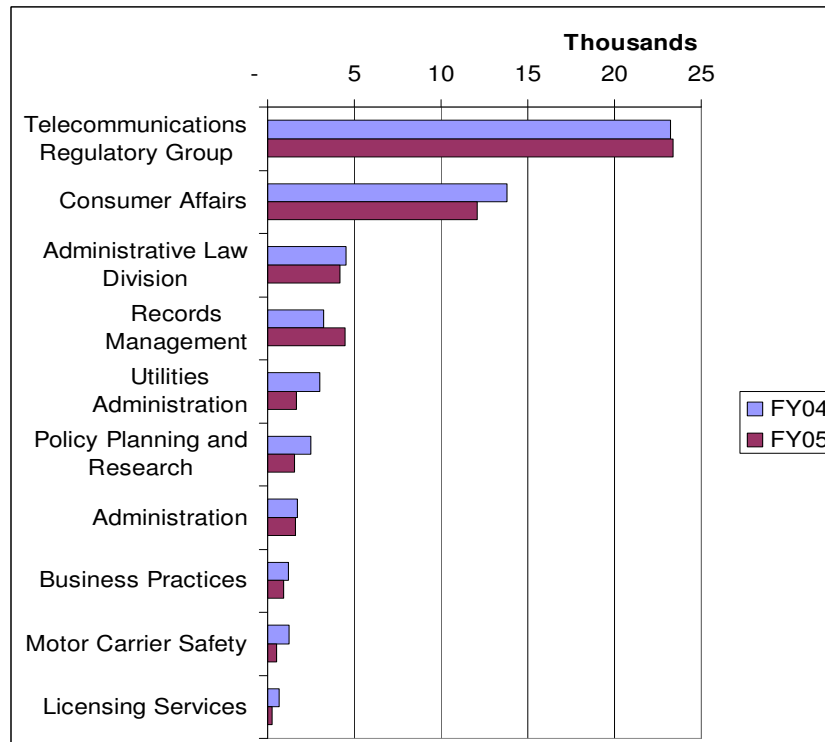
Part II. C. Choosing the right chart > **1. Categories = column or bar charts**

Bar or Column charts show differences among categories.

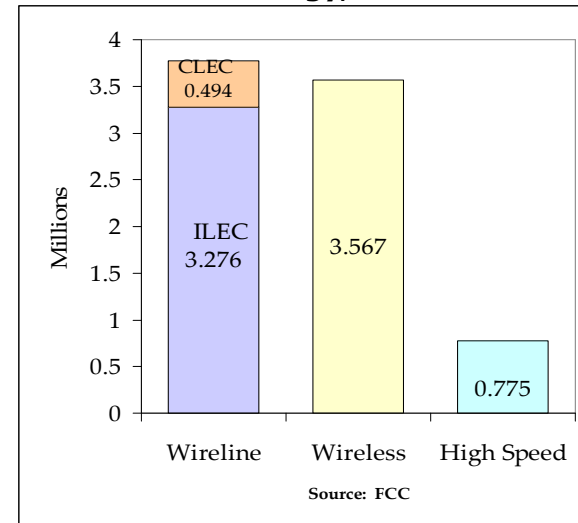
The example on right shows number of customers of different types of telephone companies. (This is a type of "stacked column" graph.)

For long lists of categories, use horizontal bars because the chart category labels are easier to read. In Excel, these are called "Bar charts". See example below.

Hours charged to telecommunication industry code by different WUTC sections, fiscal years 2004-2005



Washington telephone lines by type of technology, 2003.



Notes:

Numbers are millions of subscriber lines.
 ILEC = Incumbent local exchange company, or a traditional land-line telephone company
 CLEC = Competitive local exchange company
 FCC = Federal Communications Commission.

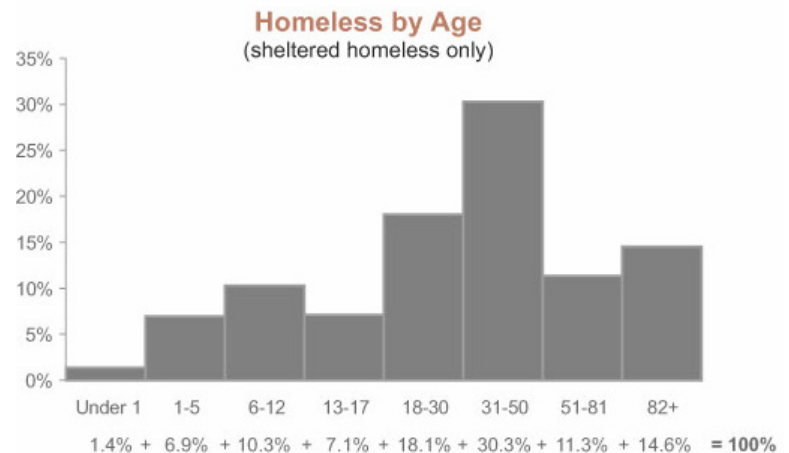
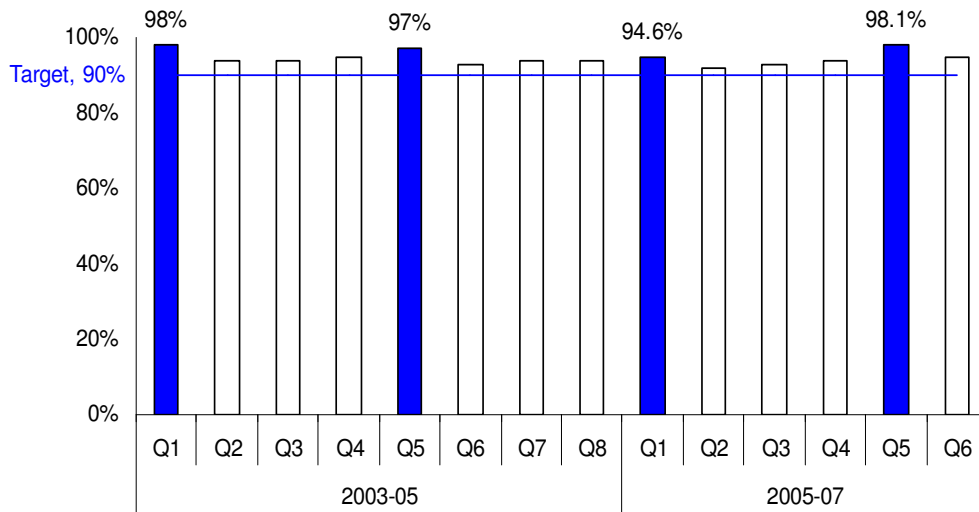
Chart sources: WUTC Telecommunications GMAP, Dec. 2005.

Part II. B. Choosing the right chart > 1. Categories = bar charts > **More bar and column chart examples**

Because statistical analysis requires a minimum of seven data points, some analysts suggest using bar charts instead of line charts if there are six or fewer data points available.

In the example below, the categories are age groups. Note the detail at the bottom showing the percentage of each category summing to 100%.

Percent of client children with paternity established per year
(cumulative to Federal Fiscal Year end, Q1 & Q5)



The data above are cumulative every quarter, so the most relevant period is the total in the final quarter. Because the eye is attracted to dark things, I wanted to draw attention to these bars are colored dark. It's difficult to draw attention to a single point in a line chart, so a bar chart works here.

Source: DSHS ESA charts – PowerPoint

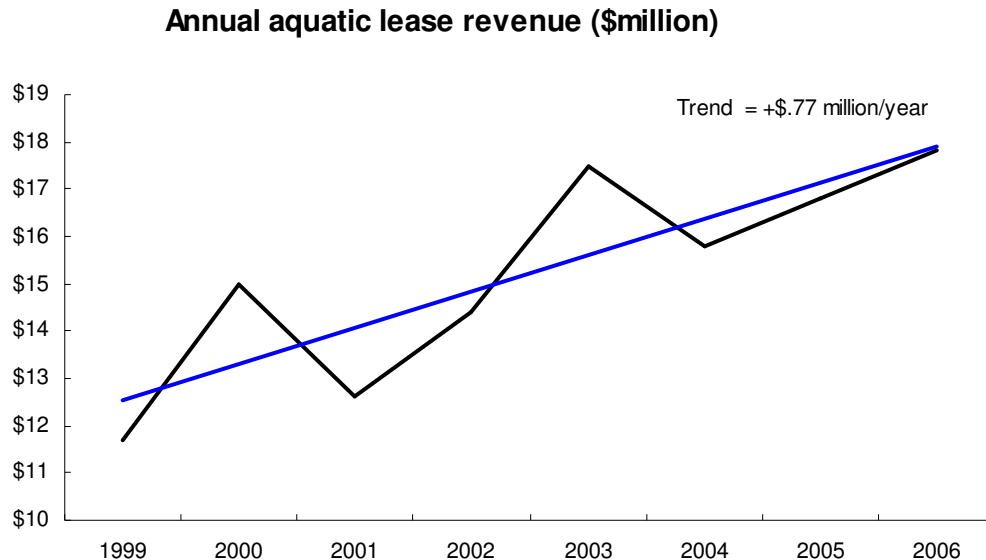
Source: Stephen Few, Perceptual Edge – Design Examples:

<http://www.perceptualedge.com/images/example15-sol-large.jpg>

Part II. B. Choosing the right chart > **2. Comparison in time = line charts**

2. Line charts (or “run charts”) show performance over time

If one of the sets of data is related to time (e.g. quarter, month, year), then a line chart is probably the right choice.



Source: DNR Performance Assessment, data from DNR Annual Reports

A big advantage of run charts is that relationships among many data points is much easier to see and understand than “raw data” in a table.

This is the data table for the chart to the left:

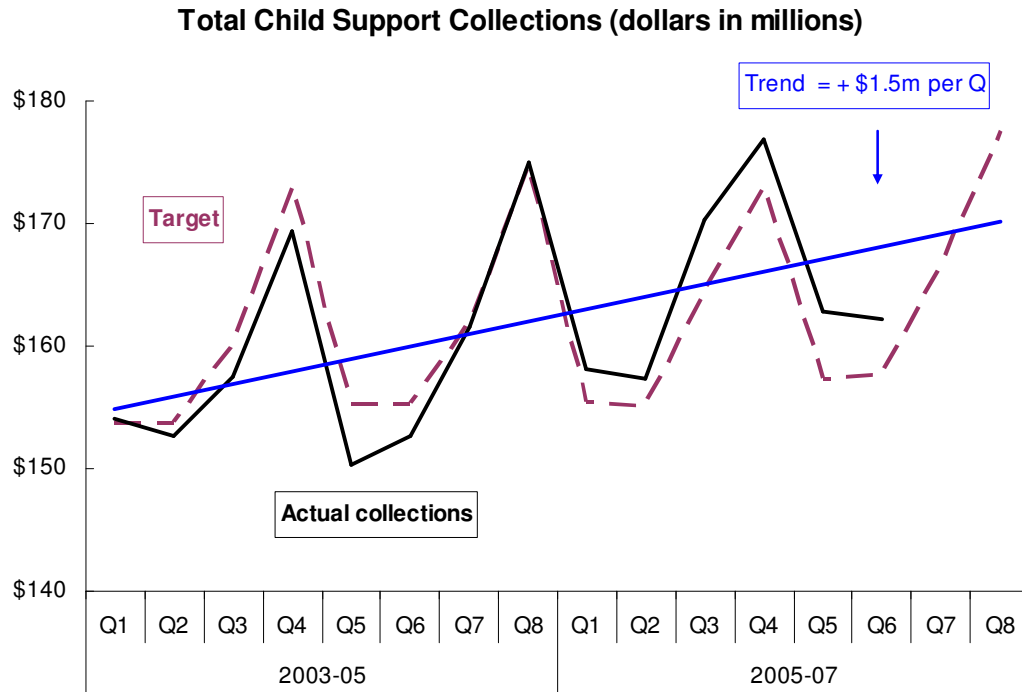
Year	Aquatic lease revenue
1999	\$11.7
2000	\$15.0
2001	\$12.6
2002	\$14.4
2003	\$17.5
2004	\$15.8
2005	\$16.8
2006	\$17.8

It’s possible to get the same information from the table as from the chart (e.g., Which year was highest? Which was lowest? Is there a general trend?) but it takes a lot more time and effort by the user.

Part II. B. Choosing the right chart > Time change = line charts > **More line chart examples**

1. Line or run charts - More examples

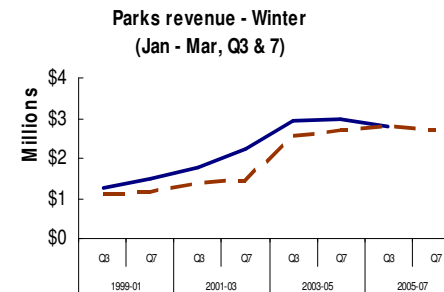
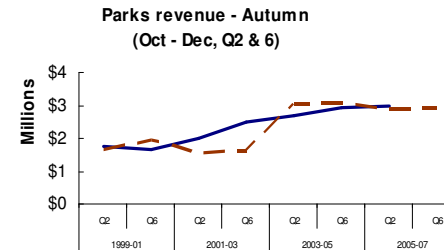
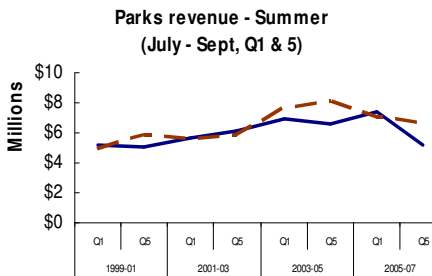
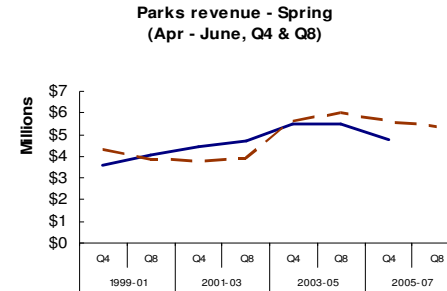
Line charts are useful for showing things that change in a regular cycle, outlying or unusual events, etc.



Note that the dollar scale begins at \$140 million. Some variation may be relatively minor, but still important to see closely. Changing the scale of the Value Axis (y axis) can highlight differences. Use this judiciously, though, as it can be perceived as manipulating the data.

Chart sources: Performance Assessments, DSHS ESA (above) and State Parks (right)

Small multiples help comparison (Tufte)



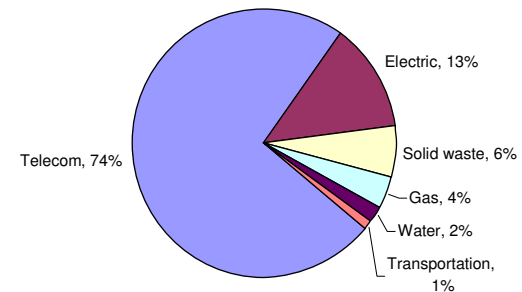
Part II. C. Choosing the right chart > **3. Parts of the whole = pie charts**

3. Pie charts show percentages of the whole

Use pie charts to show percentages, usually when there are a few (e.g. seven or less) categories, such as the chart on the right.

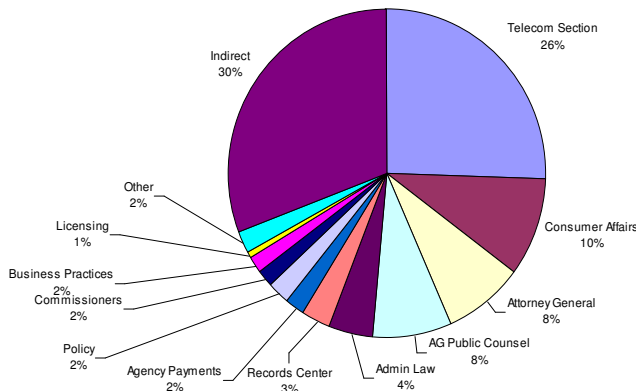
Avoid pie charts if there are many categories, such as the example below, or if any categories have a value of zero. In these cases, use a simple table of data, or an expanded pie chart, instead.

Consumer complaints by industry, 2004



Expenditures on Telecom Regulation, By Section
July-December 2003

Total Expenditures (6 months) - \$2.5 million



Hint: Rotate pie chart slices to draw users' attention to what's important, or to make it easier to read by orienting to familiar clock hand positions: "3 - 6 - 9 -12".

Reference: Stephen Few, "Save the pies for dessert" (Aug. 2007), <http://www.perceptualedge.com/articles/08-21-07.pdf>

Part III. A. Noise – What is it?

Noise is any unwanted energy or distraction that degrades the quality of signals and data.

Examples of noise:

- Hiss, hum or crackle in a telephone call
- A motorcycle going by a sidewalk café as you're about to propose
- Motors, fans, compressors at work
- Non-essential "chart junk" in a graphic.

Avoiding and reducing physical noise is a major concern of communication scientists.

Avoiding and reducing chart noise is a major concern of communicating with graphics.

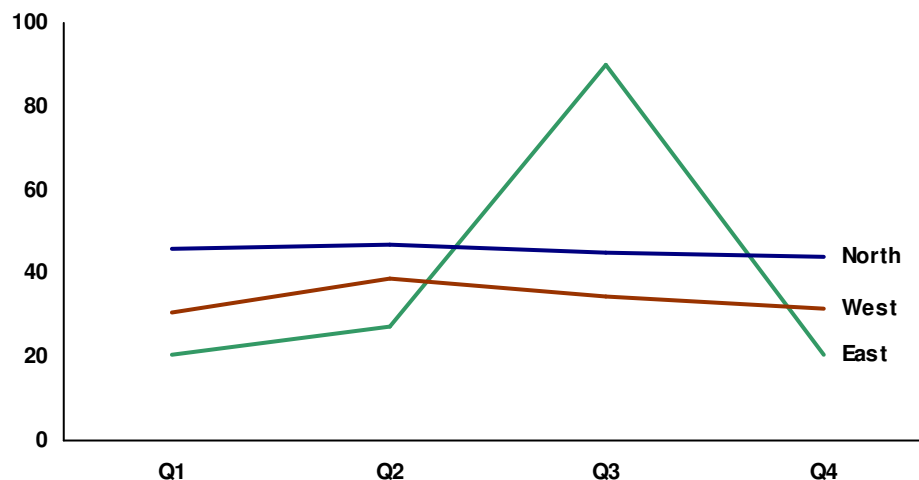
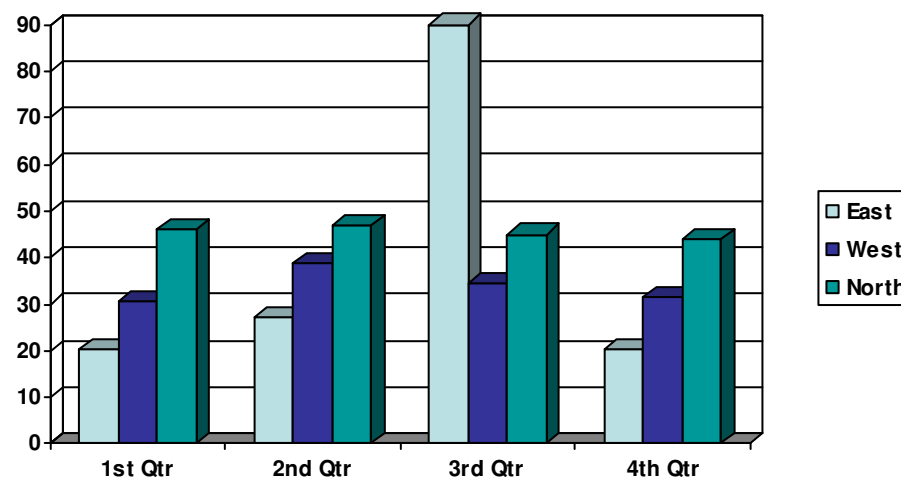
Noise can be measured by counting all of the separate things on a chart.

The default PowerPoint chart (above) has over 200 lines, tick marks, edges, surfaces, digits, and words competing for attention.

The edited version (bottom, showing the same data) has about 22.

"The only question you should ask when looking at a ... chart is: Does it communicate the data in the clearest and most accurate way possible?" Stephen Few, "[Excel's new charting engine](#)"

For technical discussion of noise in communications, see: <http://www.cultsock.ndirect.co.uk/MUHome/cshtml/introductory/sw.html#pnoise>



Part III. Noise > **B. Sources of noise in charts and graphs**

Noise can come from a variety of things in charts (and Excel puts almost all of them into charts by default).

Examples of “noise” that distract from the message in a chart . . .

Legends or “codes” that force the viewer to consult a “decoder” for meaning

Colored or shaded background

Gridlines, borders, tick marks – “Chartjunk”

Superfluous words and digits (decimal points, ‘000’s on currency, letters, words)

. . . And how to cure that particular noise problem:

Delete the legend, and instead label lines or bars directly:

- Use text boxes (from the drawing toolbar) or
- Label a data point and then edit that.

Extra benefit: legend takes up real estate from the data.

Remove colored backgrounds using “Format Plot Area”

- Remove gridlines by clicking on them, and choosing “clear”
- Remove borders by clicking on Plot and/or Chart area, and choosing Border and Patterns – none.
- Remove tick marks, or point them inside, by clicking on the axis, choosing “Format Axis”, and the Patterns tab.

Click on the axis, choose Format Axis, and then Number or Scale tabs. Minimize the number of digits, letters, words.

“The only question you should ask when looking at a . . . chart is: Does it communicate the data in the clearest and most accurate way possible?” Stephen Few, [“Excel’s new charting engine”](#)

Part IV. Practical tips > A. How to create a chart in Excel

Highlight the area of the table you want to the graph

- Click on a cell in one corner of the data table,
- hold the button down and drag the mouse to the opposite corner, and release the mouse button.
- Include all data you want to be in the graph.
- "X axis" labels can be added later.

Click the "Chart Wizard" icon on the tool bar & just follow instructions on the chart wizard:

- Choose best type of chart for the data and message
- Choose the chart sub-type with the minimum noise (note the "View sample" button)
- Add chart title (optional, can add later through "Chart Options" menu)
- Choose where to put the chart:

In same worksheet

Advantages:

- Data is right next to the chart, so easy to play with;
- Smaller size exports well to a partial page in another document (Word, Powerpoint)

Disadvantages: Limited room for detail, labels, call-outs

On its own worksheet:

Advantages:

- Large size, easy to read and work with,
- Exports well to a full page in other documents

Disadvantages:

- Data is on a different sheet so is challenging to manipulate;
- Exporting to less-than-full page in another document requires extra handling (e.g. changing font lock)

See Exercise 1 – DNR Volume of Timber sold

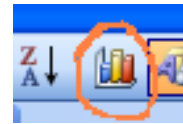
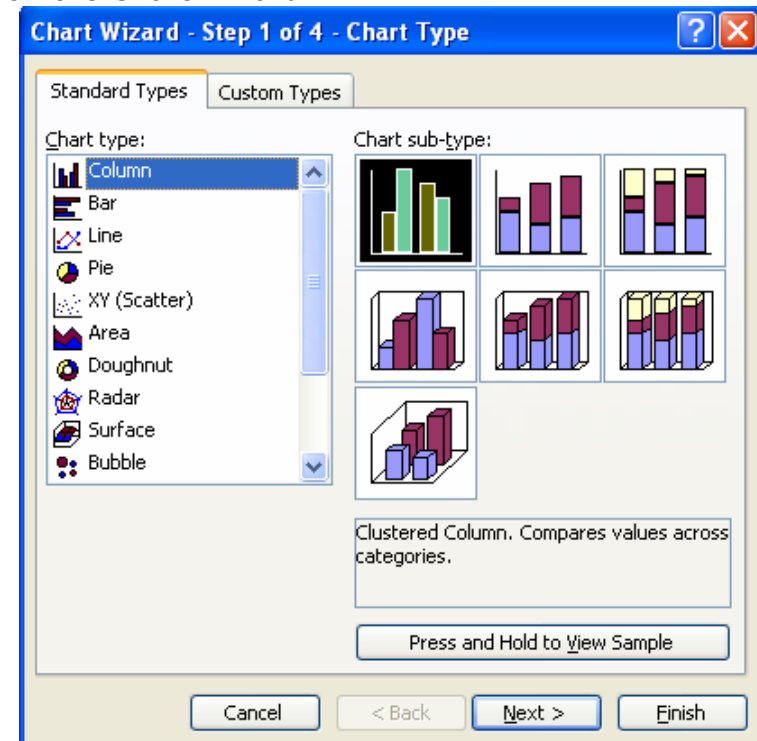
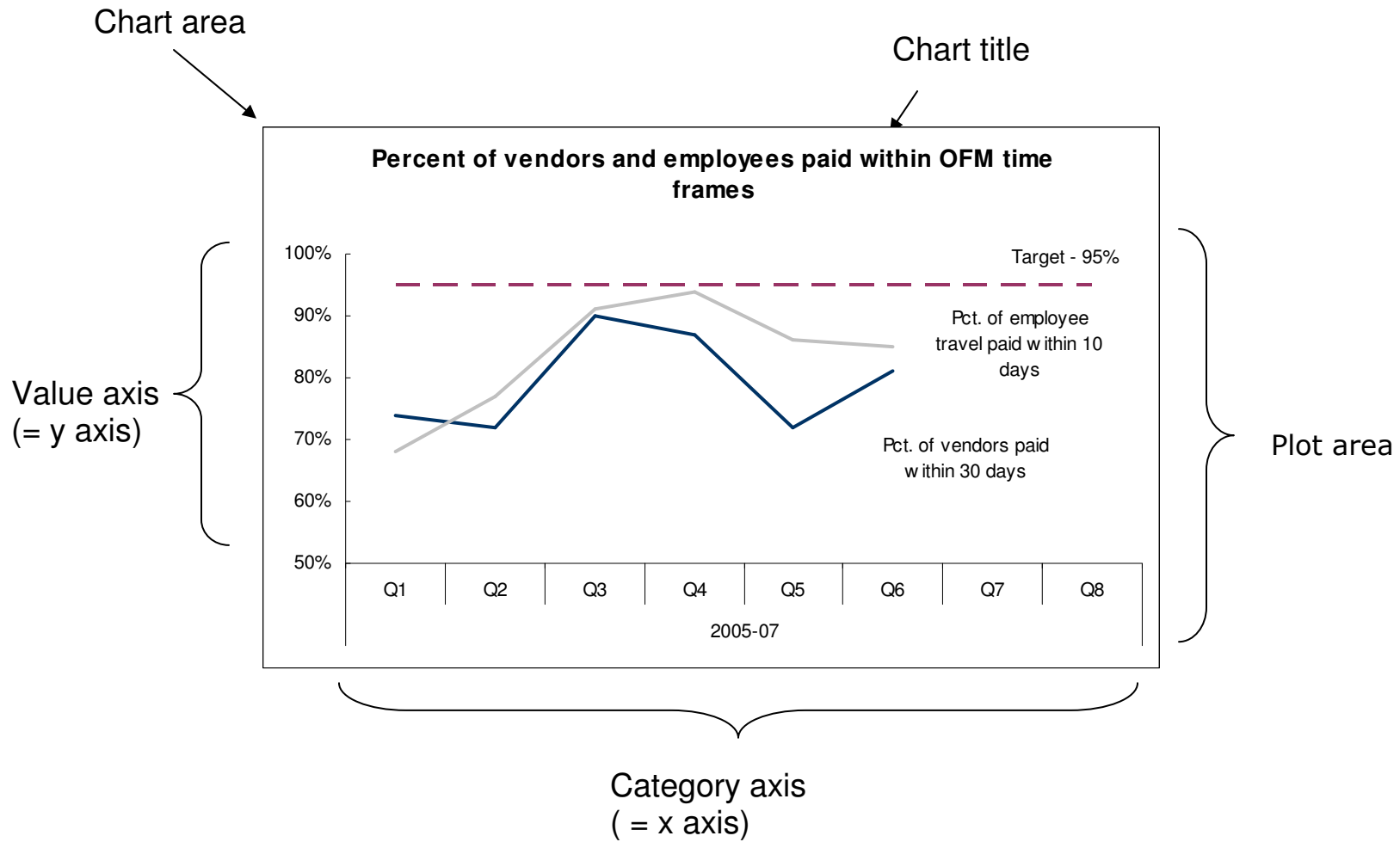


Chart Wizard icon on the menu

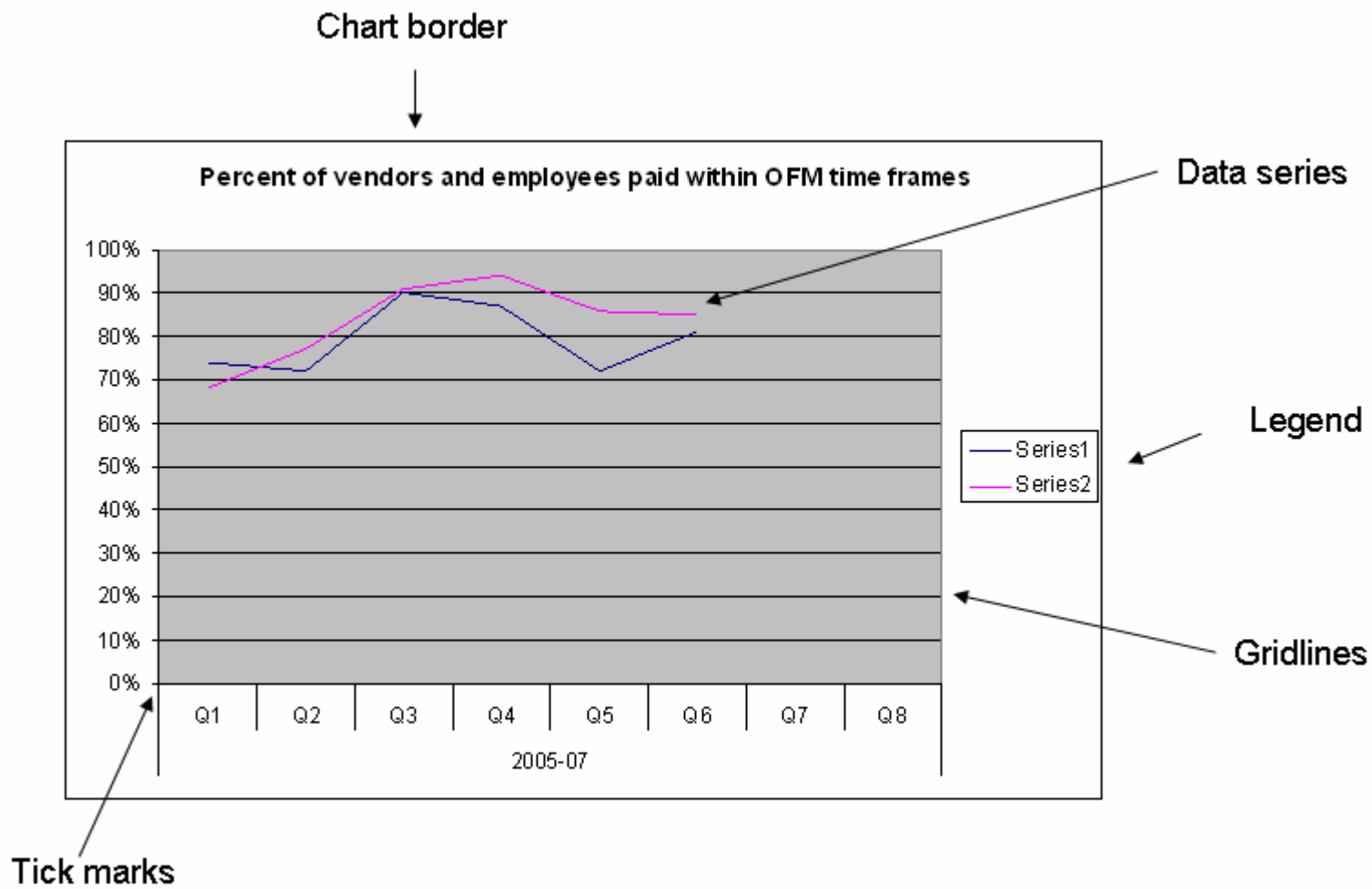
The prompt for choosing chart type and subtype on the Chart Wizard:



Part IV. Practical tips: How to clean up an Excel chart > **B. Parts of an Excel chart 1**



Part IV. Practical tips: How to clean up an Excel chart > **B. Parts of an Excel chart 2**



Part IV. Practical tips > **C. How to clean up an Excel chart –General approach**

1. Put cursor on part of the chart that you want to edit

- Black boxes appear on the ends or edges of the selected item
- Lines and borders appear mottled
- A description box may also appear (see item 1).

2. Right-Mouse-Button (RMB) click to see menu of options for that feature (see item 2).

3. Choose the "Format..." menu

4. Edit the item you want

- Menu items often have multiple tabs, each dealing with a different feature (e.g. font, lines, scale)
- Change items by choosing something different than current settings, usually "none", "no fill", etc.

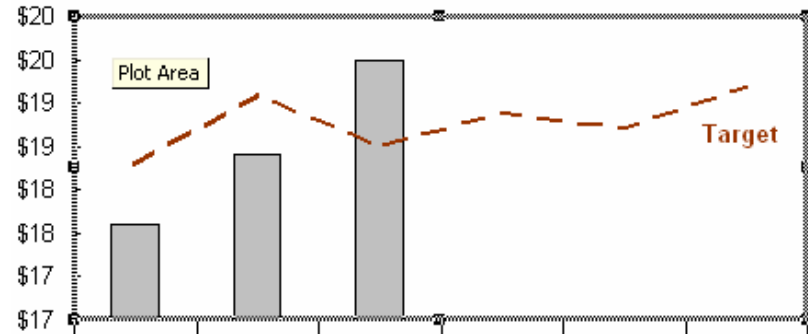
5. Click the "Okay" button or press "Enter"

Remember:

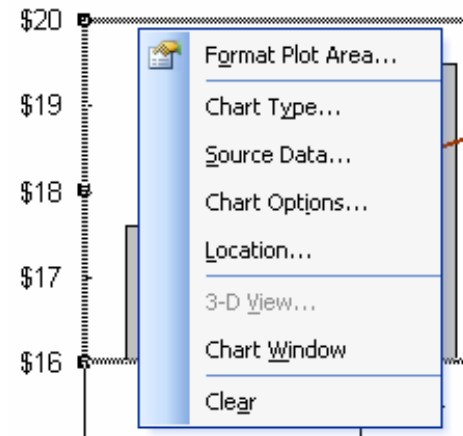
- It's okay to explore. There's more here than I can show, and it's a great way to learn.
- For peace of mind save your work early & often.
- Use "Edit - Undo" when something goes wrong.

1. Example of a selected "Plot Area" in a chart (note black squares and gray line)

All aquatic land revenue (\$million)



2. Menu of choices after Right-Mouse-Button click on highlighted Plot Area:



Part IV. Practical tips > **D. Good chart hygiene - What to clean up every time**

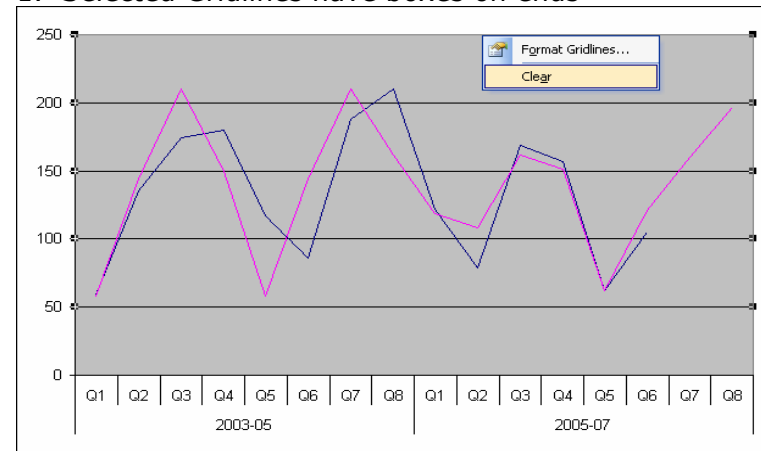
B. What to clean up every time:

- **Delete legend** - Highlight it and push "Delete" or "clear". Your chart immediately will have additional "real estate"
- **Remove gridlines** (see item 1)
 - Click on them, then push "Delete" or clear
- **Get rid of background color and inner border**
 - Put cursor in Plot Area (see previous slide)
 - Right-mouse-button click and choose "Format Plot Area" from the menu
 - Choose "Area - None" and "Border - No line" (see item 2)
- If exporting to Word or Powerpoint, remove the outer border in the same way
 - Put cursor in Chart Area (not the Plot Area, i.e. not within the area bounded by the two axes!)
 - Choose "Border - none"

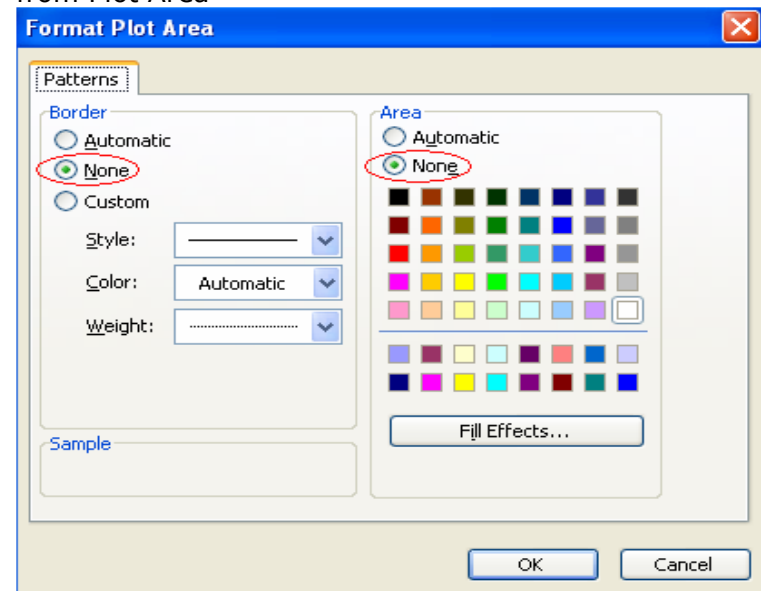
Hints:

- In general, start at outside and work your way in
- Since this happens on every chart, lots of chance to practice, get good at it.
- Can be done in about a minute or so, and pays immediate dividends in improved readability.

1. Selected Gridlines have boxes on ends



2. Menu choice for removing background and inner border from Plot Area



Part IV. Practical tips > **E. Optional things to clean up**

Further ways to reduce noise or focus on the message:

Change tick marks - I like them to point inward, toward the data, not outward like little saw teeth. Some folks eliminate them.

Unneeded digits on the value (y) axis - Some scales have too many data points, too many decimals, or too many zeros.

For all these

- 1. Highlight the Value axis (= y axis)**
- 2. Right-mouse-button click**
- 3 Choose "Format Axis . . ." menu**

To change Tick marks:

Patterns tab

"Major tick mark type" - choose "Inside", or "None"

To clean up excess decimals in numbers:

Number tab

Choose "Number" or "Currency"

Set Decimal places = 0

To change the scale:

Scale tab

Change the "Minimum" amount

Change the "Major unit" amount

To clean up excess zeros in values:

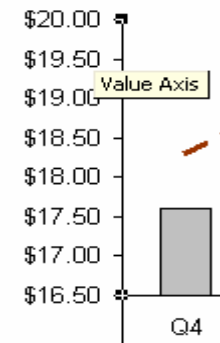
Scale tab

"Display Units" box

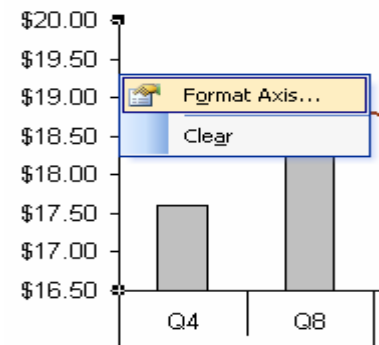
Select the one you want (hundreds, thousands, millions, etc)

The axis label will automatically change ("In Millions")

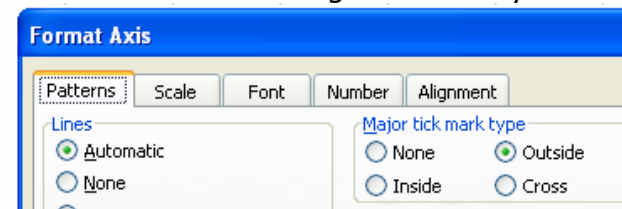
1. Highlight value axis (note black squares):



2. Right-mouse-button click to see menu:



3. Pick the tab dealing with what you want:



Part IV. Practical tips > **F. Advanced topics 1 – Using “Data Point” to make a single bar dark**

To draw attention to a single bar by coloring it dark:

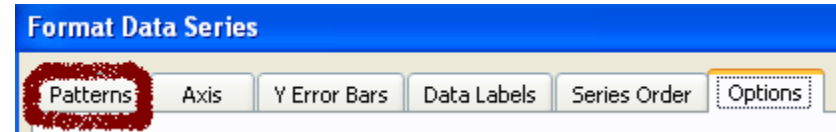
First color rest of the bars white or light

- Put cursor on any item **in the data series** and click once – the whole series is highlighted.
- RMB click, choose “Format Data Series”
- Under the Patterns tab, choose the color in Area (see item 1).

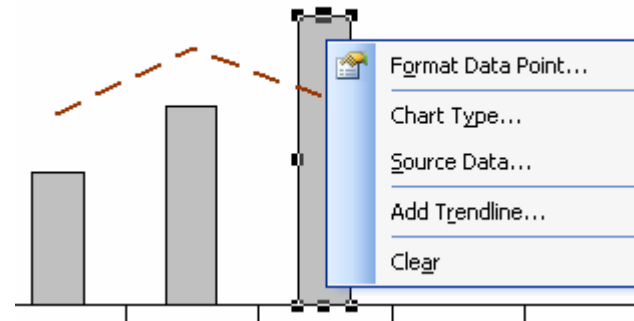
Then highlight the individual bar (= “data point”)

- Put your cursor on the data point you want to highlight
- Click once to highlight the data series.
- Click a second time and hold it– the data point is highlighted (see item 2)
- RMB click, choose “Format Data Point”
- Change color under Area, and click Okay (see item 3).

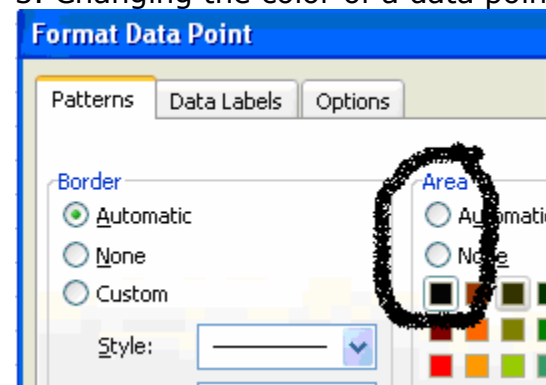
1. Tabs on the “Format Data Series . . .” menu:



2. A highlighted data point in a bar chart:



3. Changing the color of a data point



Part IV. Practical tips > **F. Advanced topics 2 – Enhance the message in the data lines**

Add emphasis to the message by increasing the weight of a data line

- Click on the data series
- RMB click and choose "Format Data Series"
- On the first "Patterns" tab,
- Under "Line", increase the weight (bottom option)

Provide a visual clue that the target is not actual data by changing it to a dashed line

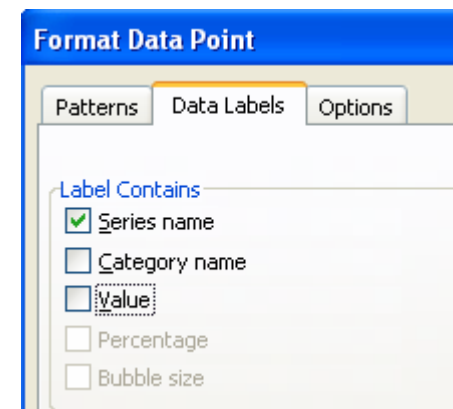
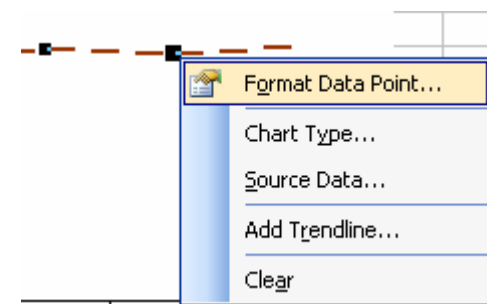
- Same as above, but under "Line" . . .
- click "Style" (top option) and choose a type of dashed line
- Consider changing the color as well (middle option)

Label the lines directly to replace the deleted legend:

Method 1 - Use text boxes from the "Drawing" toolbar. (Hint – your cursor needs to be in the Chart Area when creating the text box, or it will disappear behind the chart)

Method 2 - Label a data point, then edit and move it:

- Get to any data point on the line (see previous slide 21)
- Choose "Format Data Point," then the "Data Labels" tab
- Click one of the choices (Series, Category or Value it doesn't matter)
- Once the data label is created for the data point, edit it and move it
 - Click twice on the data label to move it around the chart area
 - Click three times on the data label to edit the text
 - Click on it once to get the "Format Data Label" to edit font (e.g. make font color to match the line color), make it bold to be more readable, etc.



Part IV. Practical tips > **F. Advanced topics 3 – Adding other data lines**

Excel can include a **trend line**:

- Click on the main chart line (i.e. data series), and choose
- “Add Trend line” from the menu choice.
- Can show slope, check R-squared, on one of the tabs

How to get a **mixed bar and line chart or data on two axes**:

- Click pretty much anywhere in the chart and RMB click
- Choose “Chart Type” on menu
- Click on the “Custom chart” tab (on the right at top)
- Scroll down and look for “Line and bar” chart, etc.

How to **add additional series of data** (e.g. mean or median, etc.)
or define X axis labels

- Add the data in an additional column on the spreadsheet table
- Click anywhere in the chart
- Choose “Source Data”
- Click the “Series” tab
- Click “Add” and give it a name
- Click and highlight where to get the data

Part IV. Practical tips – More hints, ideas, things to think about

1. The eye reads a page like the mark of Zorro –
 - People first focus on the upper left corner of the page
 - Go across the top to the upper right,
 - diagonally back down to lower left, and
 - across bottom to lower right.

These are the four main attention corners, in that priority order. Use this to prioritize the space for users on charts, e.g.:

- Put legends in upper left corner
 - Put technical information at bottom, etc.
2. It's okay to write a chart title that draws the user's attention to the main point.
 - E.g. "Energy from renewable energy has increased 32% over past five years (measured in kilowatt hours)"
 3. Some people are color blind. Use colors that don't cause problems for these folks (avoid yellows and greens.)
 4. Think about how your graphic will reproduce in black and white. Not everyone has a color copier or printer. Using shades of gray ensures copy-ability.
 5. Think about ways to make design even less obtrusive:
 - Reduce the weight of axis lines
 - Change line or font color from black to gray
 6. Trust comes from integrity
 - State data sources, provide footnotes and explanatory text.
 - Sign your work.

Part V. Resources for improving graphic literacy

Dr. Steve Marshall and OFM's **Brian Willett** teach "Communicating with Data" classes through Dept. of Personnel (DOP).

Edward Tufte, the father of "information design," has great books, seminars, insights, and discussion groups on his website (<http://www.edwardtufte.com/tufte/>) including discussion groups (e.g. on [project management](#)).

- About Tufte: "The Data Artist", March, 1997 *Salon* <http://archive.salon.com/march97/tufte2970310.html>
- By Tufte: "PowerPoint Is Evil" (*Wired*, Sept. 03) <http://www.wired.com/wired/archive/11.09/ppt2.html>
- Influenced by Tufte: "Graphics and Web Design based on Tufte" - UW computer class: <http://www.washington.edu/computing/training/560/zz-tufte.html>

Stephen Few, and his firm Perceptual Edge, have a great web site with, for instance:

- a library of publications - <http://www.perceptualedge.com/library.php>
- "before and after" examples of graphics - <http://www.perceptualedge.com/examples.php>

Barbara Felver, an analyst with the DSHS and OFM, developed some great tips and techniques that I've borrowed (e.g. how to clean up a bar chart, decision maker questions)

<http://www.digitalarchives.wa.gov/governorlocke/improve/quality/tools/bfelver.htm>.

Start a folder and throw ideas into it. Look at examples from publications that use graphic and financial data (Wall St. Journal, New York Times, annual reports by mutual funds, etc.) Washington Department of Transportation's Gray Notebook (<http://www.wsdot.wa.gov/accountability/default.htm>) has lots of ideas for graphic communication.

Remember:

- Focus on the message
- Eliminate noise

Jeffrey Showman is a Budget Assistant at the Washington State Office of Financial Management (OFM) doing performance assessments of state agencies. In 18 years at the Washington Utilities and Transportation Commission, he did a variety of communication jobs:

- Published the agency's Balanced Scorecard
- Coached managers on presenting performance data graphically for internal GMAP sessions
- Testified to legislative committees, using charts to show performance data
- Helped design web sites and information system projects for customer usability, took training on, and conducted, usability studies
- Helped write and publish a daily electronic newsletter
- Wrote, edited, and coordinated production of reports to the legislature
- Conducted workshops and gave presentations on a variety of topics to a variety of audiences.

Jeffrey holds a Masters degree in Urban Planning from the University of Washington and a Bachelors of Science degree in Environmental Studies from Huxley College at Western Washington University, where he was also production manager of the student newspaper and a blues disk jockey.