Better charts

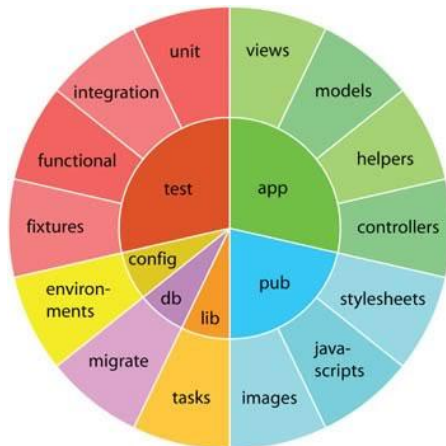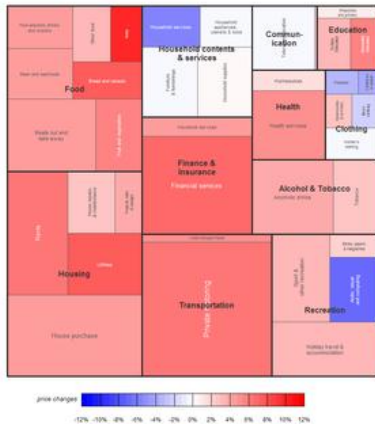## Communicating effectively and reaching your audience

Dr. Steven Struhl

Converge Analytic

Many of the problems you will escape
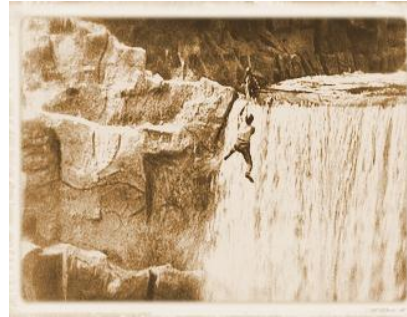
- These charts are very bad
  - Everybody knew that, of course
- But what makes them bad? And how do we do better?
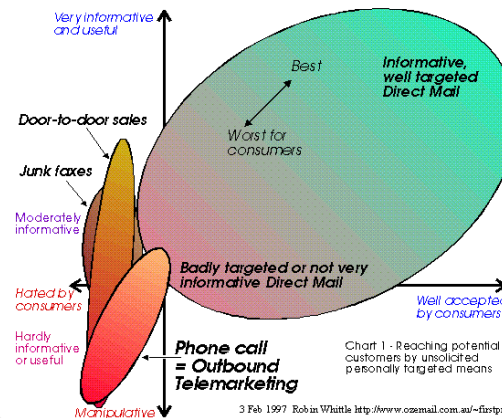
Three main areas for improving charts and graphics

- There is a lot more to this (of course) but attention to three main areas will help your charts

  - Avoid the big pitfalls

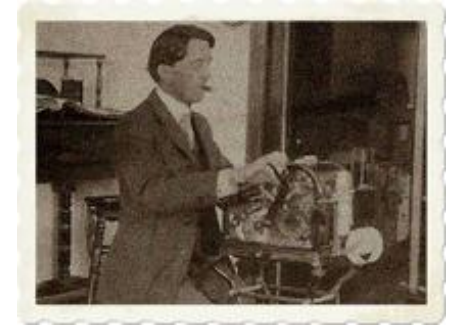 - Organize according to one principle

  - Use perception to your advantage

Converge Analytic
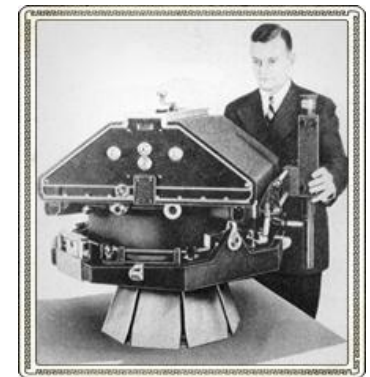
Avoid the big pitfalls

- Use small bites: People process little at one time

- Don't let decoration obscure the message

- Don't let small text make you the victim of balky equipment

- Watch out for dancing monkeys!

Converge Analytic

Use small bites: People process very little at one time

- Documents that sway behavior and make history need to get recycled up the organizational chain

- We need even more sharply reduced formats for the typical attention-impaired executive

  - The most senior persons in the room get to take out their iPhones** within ten minutes of start time
    - And they do

- This deck is like rations for regular people

- Most words would disappear for those at the upper heights

Fit for a CMO: Blackbirds strictly optional.

Nutritious but not the same

**No promotional credit was offered. "Take out their Androids" sounded too strange.*

Converge Analytic

How much is too much? Five bits of information!

- Psychologists tell us from careful tests that people can process about **four pieces** of information at one time

  - That's a dedicated audience willing to listen*

- You likely will lose the CMO, CFO and others in the "C-Suite"** before you get that far

- Consider your audience and limit content accordingly and carefully.

- A handy way to remember how much—

- One writer calls this "the rule of the four"

  - **Four pieces of information or less per slide**

*Most studies like this are based on college students, who want to please Old Doc Whatsis, their instructor (psychology has been called the study of college sophomores)
**This has nothing to do with their being former C students
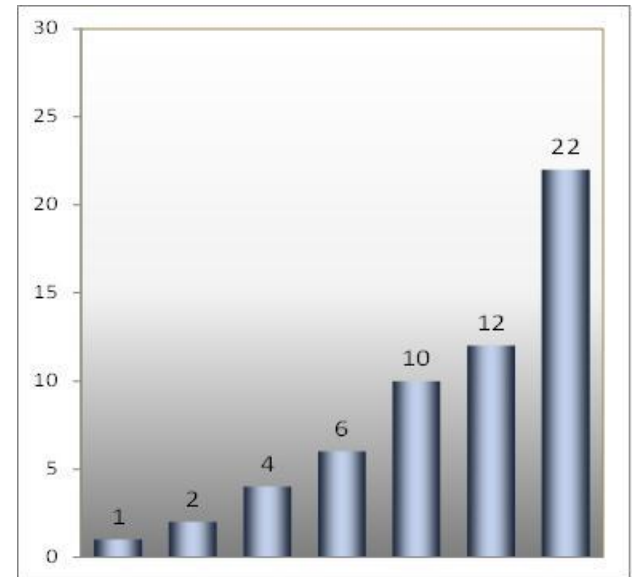

Neither is a college sophomore

Converge Analytic

Don't let decoration obscure the message
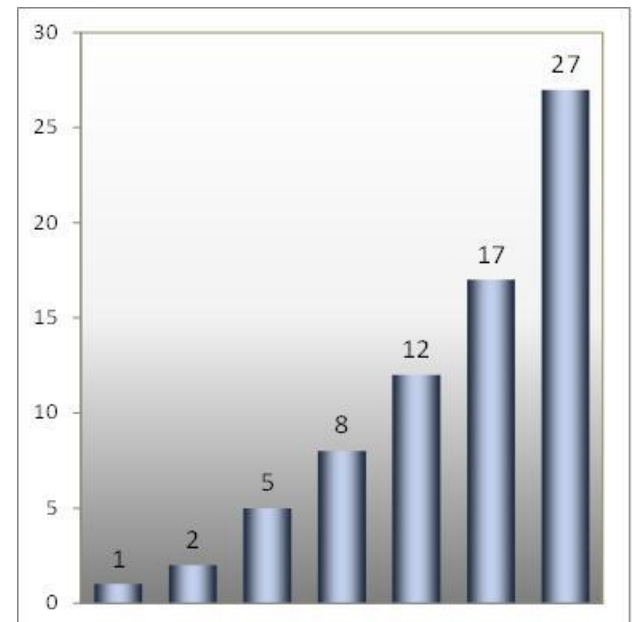
- Sort of pretty . . .

This one?

- But which one is it?

Or this one?

Converge Analytic

# Cut chart junk to communicate clearly and to engage attention

- Some authorities (especially Tufte[1]) recommend the bare minimum
  - In particular, reducing **chart junk**—extraneous non-informational elements
  - Tufte discusses (and likely invented) the **ink to data** ratio
    - He says minimize the amount of ink
- Others (e.g., Tukey[2]) stress that charts need to engage attention and interest
- All agree excess decoration is bad
- Not all agree on where excess starts
  - Some say overly plain charts do not engage attention and so fail
  - You need to decide how much is too much—and how little too little

[1]The really famous expert you may never have heard of
[2] Another really famous expert you may never have heard of

Converge Analytic

Break down complexity: it is all new to your audience

- This might seem just fine if we'd worked on the project
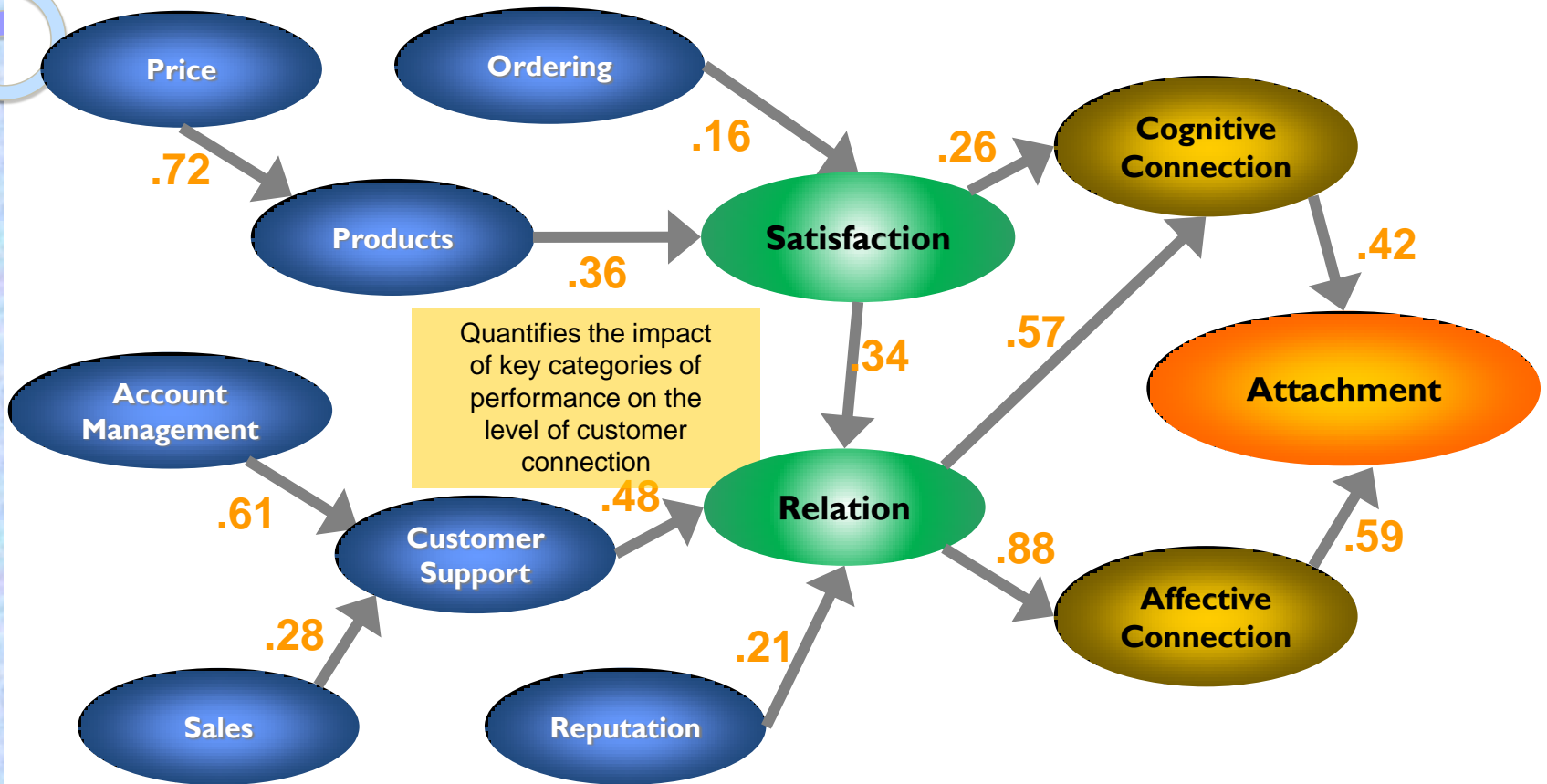
If you jump right in, viewers will have trouble seeing the point

- What your audience might think that last chart was
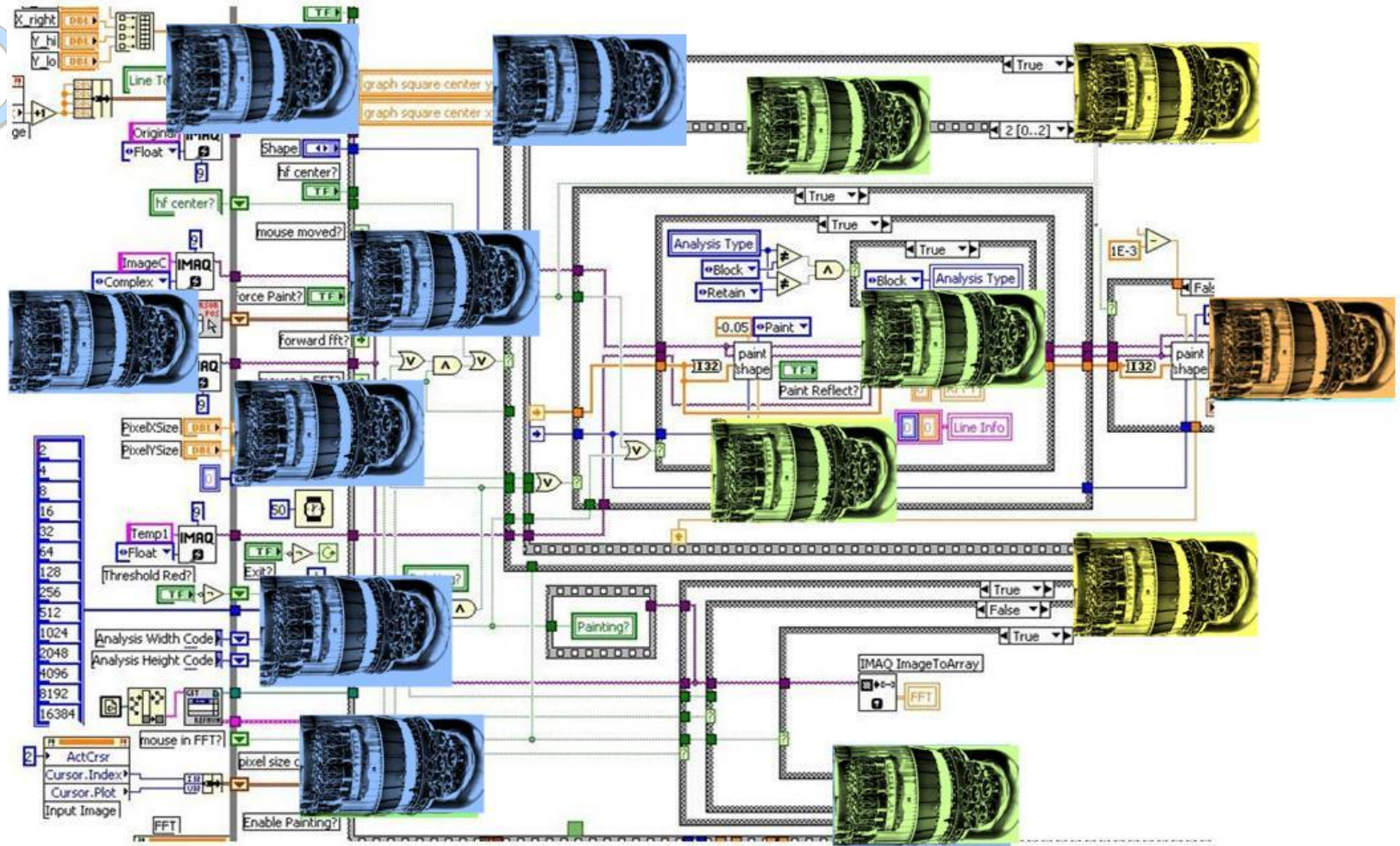
Complex ideas need a build-up and point of entry

- We need to break the big design into elements
- This is just one possible start
- We can go forward by—
  - Showing key elements and adding detail, or by
  - Showing regions or details and adding numbers
- This starts with the core elements, but there can be good reasons to go the other way

Converge Analytic
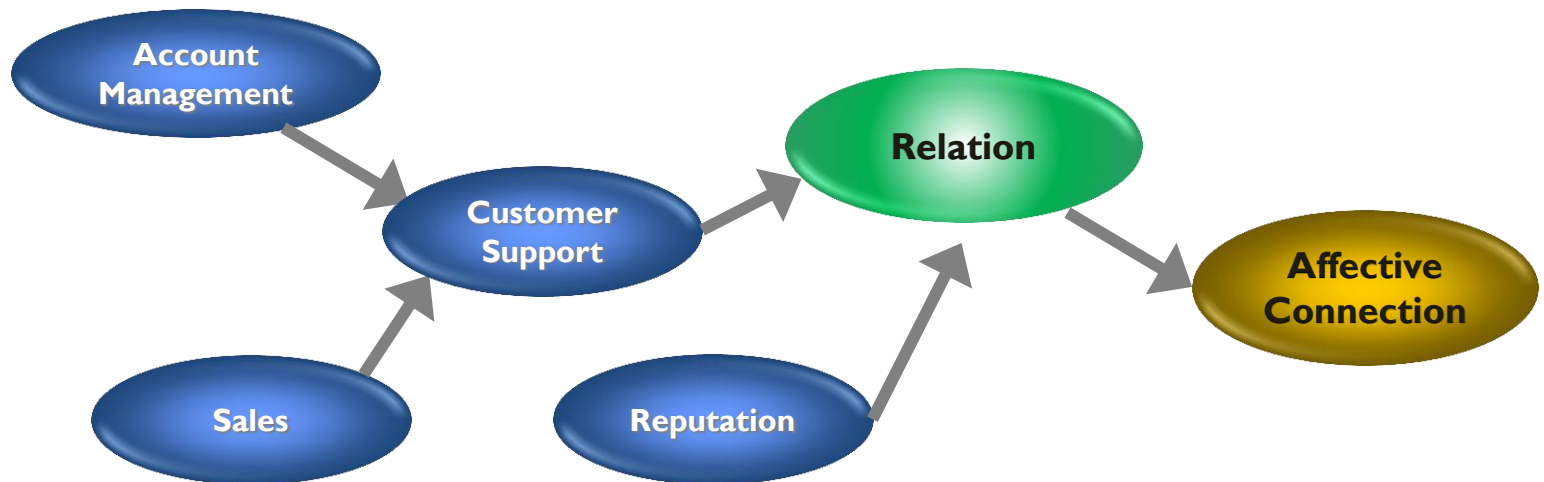
Continue step by step until you reach the bigger ideas

- For our next step, we put some numbers on the first diagram
  - We need to decide when complexity gets quantified
- For some audiences, we might just give summary measures of each variable's strength (which we can calculate from the diagram), and nothing else

Converge Analytic
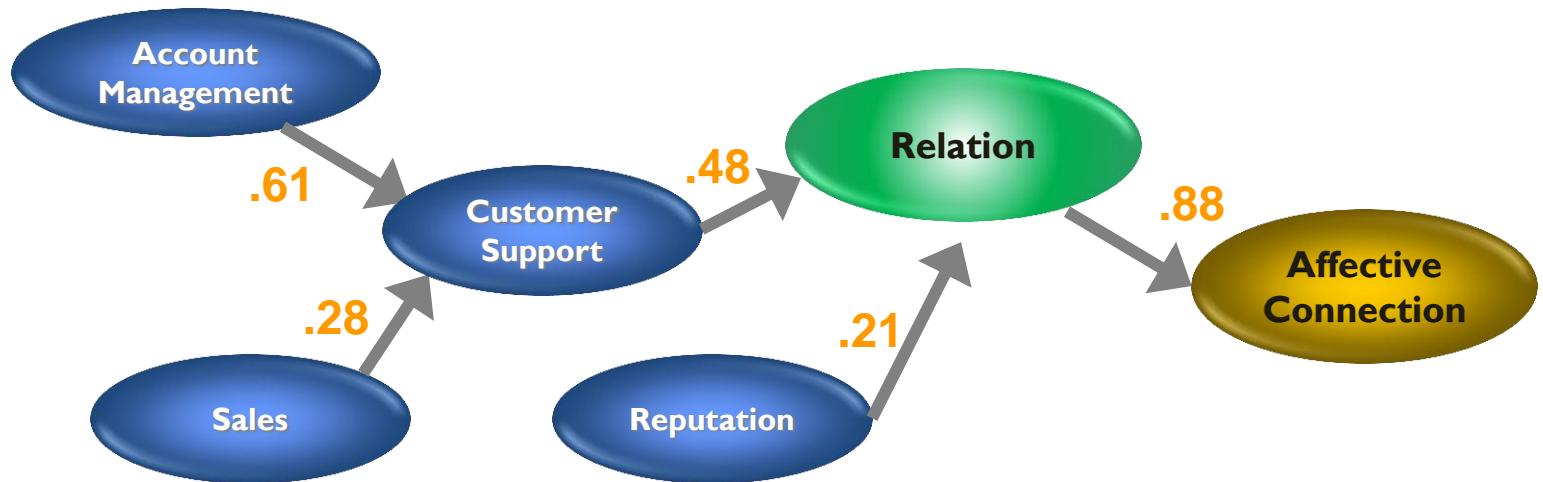
Only after careful building should we delineate the whole structure

- With luck, the audience will be curious to see this after a careful buildup, piece by piece

Price

Ordering

.72

Products

.16

.36

Satisfaction

.26

Cognitive Connection

.42

Quantifies the impact of key categories of performance on the level of customer attachment

.34

.57

Attachment

Account Management

.61

Customer Support

.48

Relation

.88

.59

Sales

.28

.21

Affective Connection

Reputation

Converge Analytic
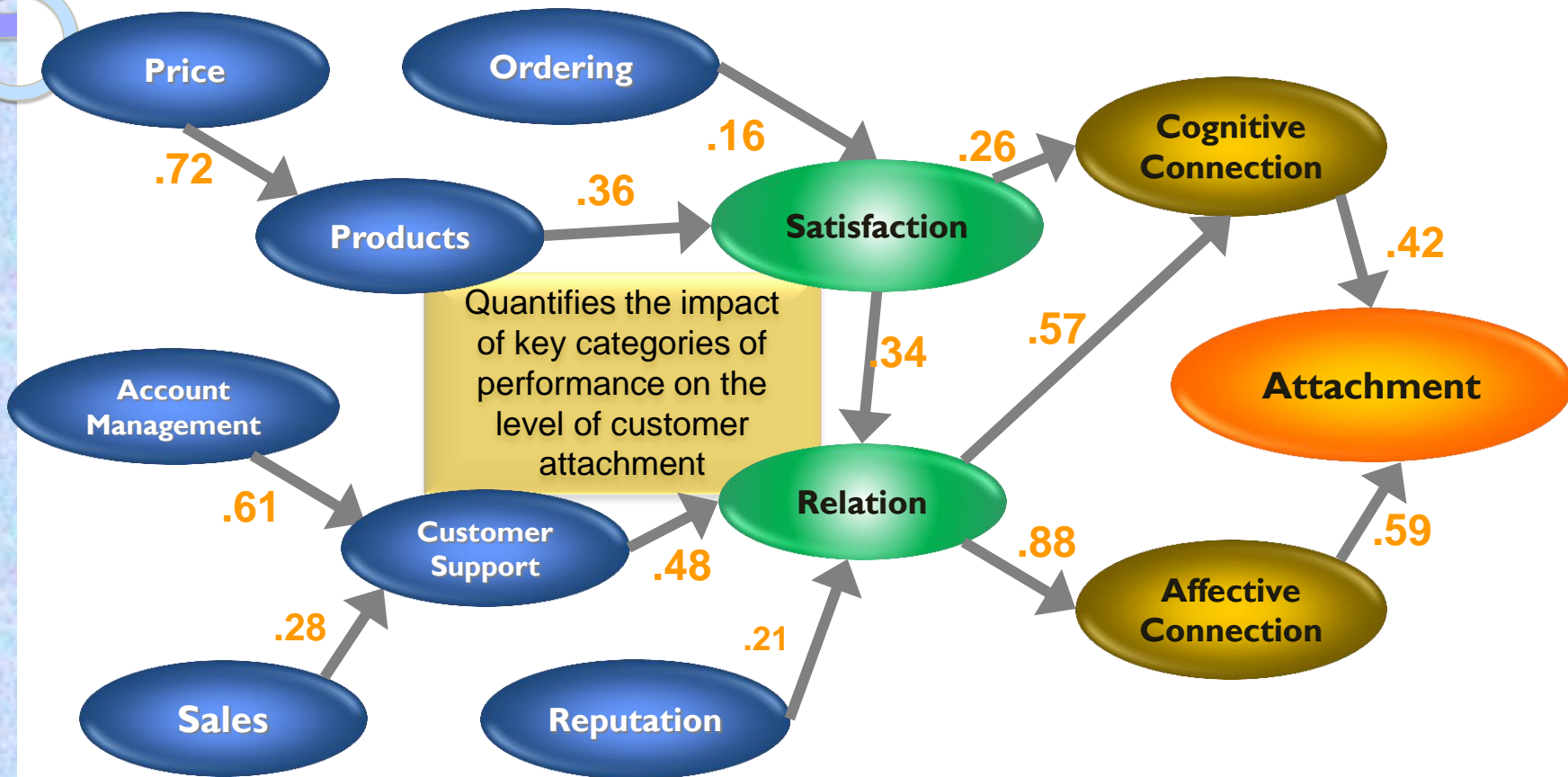
Don't let small text make you a victim of ailing equipment

- Small text can kill a show
- If you are live, "senior citizen" and "very mini" projectors hate the lower point sizes
  - Except to label charts,[1] 16 points should be the absolute minimum
    - **This is 18 points**
    - Virtual slides really are practically free—
      - Spread out the text as needed
      - Then compress for the "take home"

      - This shows
        - what
        - happens to
        - reading with
        - smaller text
        - Your disclaimer about health benefits here

This shows
what
happens to
Reverse text
with smaller text.
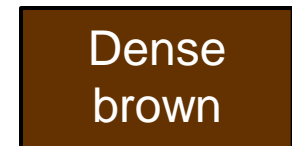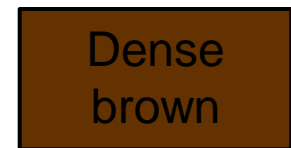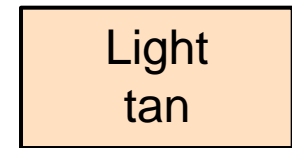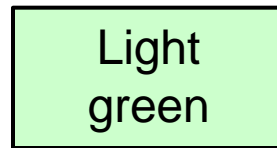Your disclaimer about
health benefits here.

[1] *Or for informative footnotes or useful captions to cartoons*

SUPPLEMENT FACTS
Serving Size: 1 scoop (20.5g)‡
Servings Per Container: 40

	Amount Per Serving	% Daily Value†
Calories	30	
Total Fat	0g	0%
Saturated Fat	0g	0%
Total Carbohydrates	7g	3%
Sugars	0g	**
Protein	0g	0%
Vitamin B6 (Pyridoxine HCL)	25mg	1250%
Vitamin B9 (Folic Acid)	400mcg	100%
Vitamin B12 (Cyanocobalamin)	120mcg	2000%
Calcium	75mg	8%
Phosphorous	500mg	50%
Magnesium	360mg	90%
Sodium	150mg	6%
Potassium	75mg	2%
N.O.-XPLODE's PROPRIETARY BLEND	20,500mg	**

(Contains A Patented Nutrient Suspension Matrix & Efforsorb™ Delivery System)

N.O. Meta-Fusion™ (Patent Pending)
L-Arginine AKG, L-Citrulline Malate, L-Citrulline AKG, L-Histidine AKG, RC-NOS™ (Rutaecarpine 95%), Gynostemma Pentaphyllum (Gypenosides 95%), NAD (Nicotinamide Adenine Dinucleotide)

Muscle Volumizing Creatine Matrix (Patent Pending)
CEM3™ (Creatine Ethyl Ester Malate), Di-Creatine Malate, Trimethylglycine, Glycocyamine, Guanidino Propionic Acid, Cinnulin PF® (Aqueous Cinnamon Extract), Ketoisocaproate Potassium

Ener-Tropic Xplosion™ (Patent Pending)
L-Tyrosine, L-Tyrosine AKG, Taurine, Glucuronolactone, Methylxanthine (Caffeine), MCT's (Medium Chain Triglycerides), Vinpocetine 99%, Vincamine 99%, Vinburnine 99%

Phospho-Electrolyte Replacements™
Di-Calcium Phosphate, Di-Potassium Phosphate, Di-Sodium Phosphate

Glycerol Hydrating Polymers™
Potassium Glycerophosphate, Magnesium Glycerophosphate, Glycerol Stearate

† Percent Daily Values are based on a 2,000 calorie diet. / **Daily Value Not Established

Other Ingredients: Maltodextrin, Natural & Artificial Flavors, Citric Acid, Sodium Bicarbonate, Sucralose (Splenda®), Acesulfame-K, Potassium Citrate, FD&C Red #40, FD&C Blue #1, Calcium Silicate.

‡ Due to settling, a natural occurrence with powders, variations in the powder height level may vary from bottle to bottle. Additionally, powder density may be affected as a result of the settling which may cause slight variations in the scoop serving size.

Allergen Warning: Manufactured on equipment which processes products containing milk, egg, soybeans, shellfish, fish oil, tree nuts, and peanut flavor.

WARNING: Before consuming N.O.-XPLODE seek advice from a health care practitioner if you are unaware of your current health condition or have any pre-existing medical condition including but not limited to high or low blood pressure, cardiac arrhythmia, stroke, heart, liver, or thyroid disease; anxiety, depression, seizure disorder, psychiatric disease, diabetes, pernicious anemia, difficulty urinating due to prostate enlargement, or if you are taking an MAO inhibitor or any other medication. Do not use if you are pregnant, nursing, prone to dehydration, or exposed to excessive heat. Reduce or discontinue use if sleeplessness, tremors, dizziness, nervousness, headaches, or heart palpitations occur. N.O.-XPLODE is only intended to be consumed by healthy adults 18-50 years of age. Keep out of reach of children and pets.

*These statements have not been evaluated by the Food and Drug Administration. This product is not intended to diagnose, treat, cure or prevent any disease.

N.O. XPLODE "is not intended to diagnose, treat, cure or prevent any disease." But does it remove tar?

Converge Analytic

Colors often are not what they should be

Projectors may surprise you as they transform these; black and white printers as well

Light blue	Light green	Light pink	Light tan
Mid blue	Mid green	Mid red	Mid brown
Dense blue	Dense green	Dense red	Dense brown
Dense blue	Dense green	Dense red	Dense brown

Dark on light is reverse type—reverse often prints poorly and may project poorly

Converge Analytic

Watch out for dancing monkeys!

- These are three dance moves from an animated .gif file
- If we would let this image move, everybody would be watching the cute monkey dancing

- Presenting is hard enough without being upstaged by a cartoon
- Motion is a real distractor
- Keeping people focused requires cutting distractions

Converge Analytic

Decide on the main point and organize using it

Converge Analytic
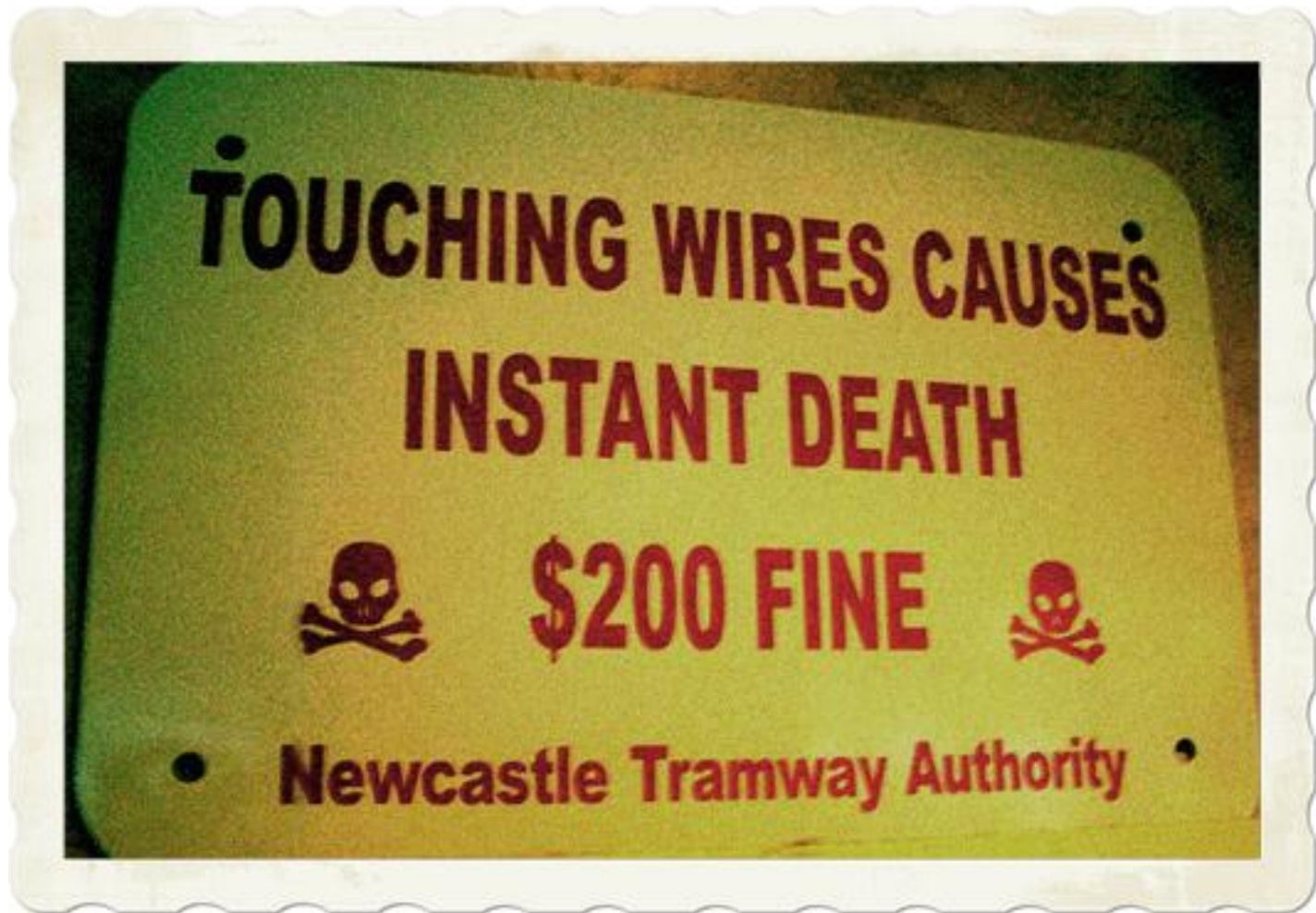
Decide on the main point and use it to organize

- Sometimes pages try to communicate too many messages

- Superfluous items can dilute each other and result in everything being given less weight

- This implies a need to get a firm grip on the main point, say what is needed and little more

Converge Analytic

Getting better about communicating the key point

- In this chart, is the main idea how important items are, or the gaps between "Us" and "Dll Enterprises"?

- The title announces this will be about gaps, but this is not ordered by gaps

- Clarity of the main graphical message gets reduced by analyzing via one principle and displaying by another

- How can we clarify this?

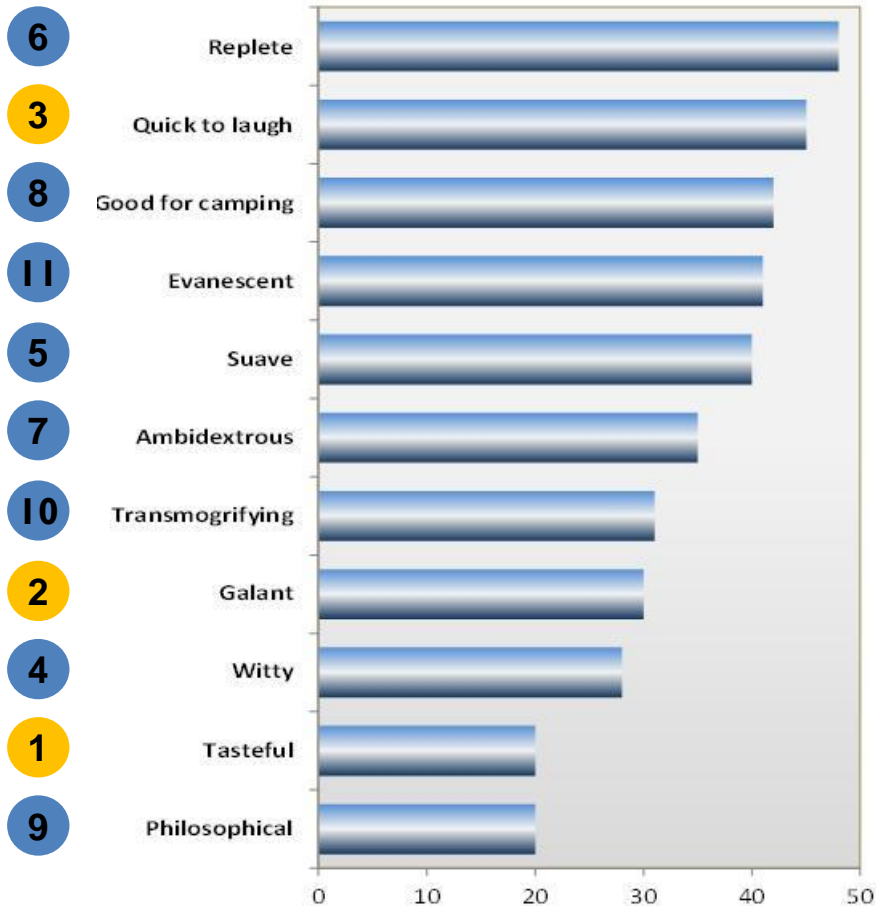**Gaps between us and DLL enterprises**
Attributes in order of importance

Gap between us and Dll Enterprises

Converge Analytic
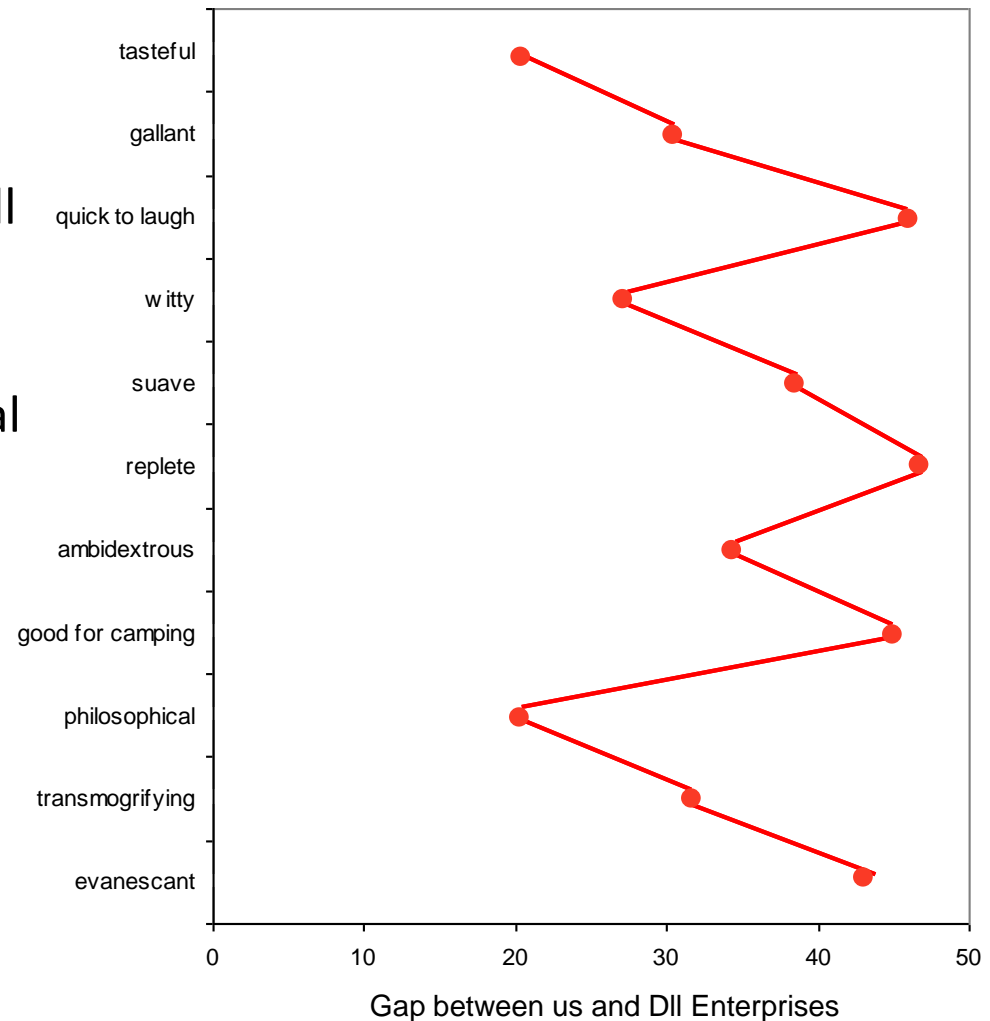
Improvements in clarity come from choosing one organizing principle

Gaps between us and them
Attributes in order of gaps,
showing importance rankings

Importance	Attribute
6	Replete
3	Quick to laugh
8	Good for camping
11	Evanescent
5	Suave
7	Ambidextrous
10	Transmogrifying
2	Galant
4	Witty
1	Tasteful
9	Philosophical

Gaps between us and them
Attributes in order of gaps,
top three, then rest,
showing importance rankings

Importance	Attribute
3	Quick to laugh
2	Galant
1	Tasteful
8	Replete
6	Good for camping
11	Evanescent
5	Suave
7	Ambidextrous
10	Transmogrifying
4	Witty
9	Philosophical

Converge Analytic
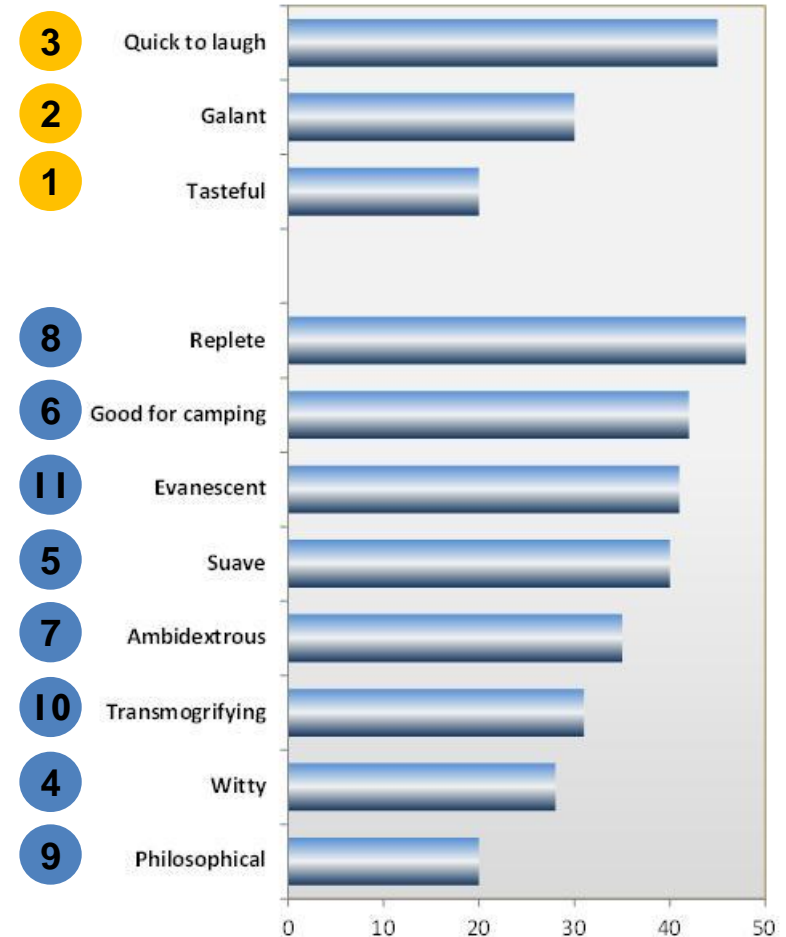
We have just made a Pareto chart

- By putting the bars in size order, you make a **Pareto chart**

  ▪ That's all it is, really

- The bars also are better than a wavy line for comparing sizes, as we will soon see

- Framing the plot area also guides the eye, making reading easier

Converge Analytic
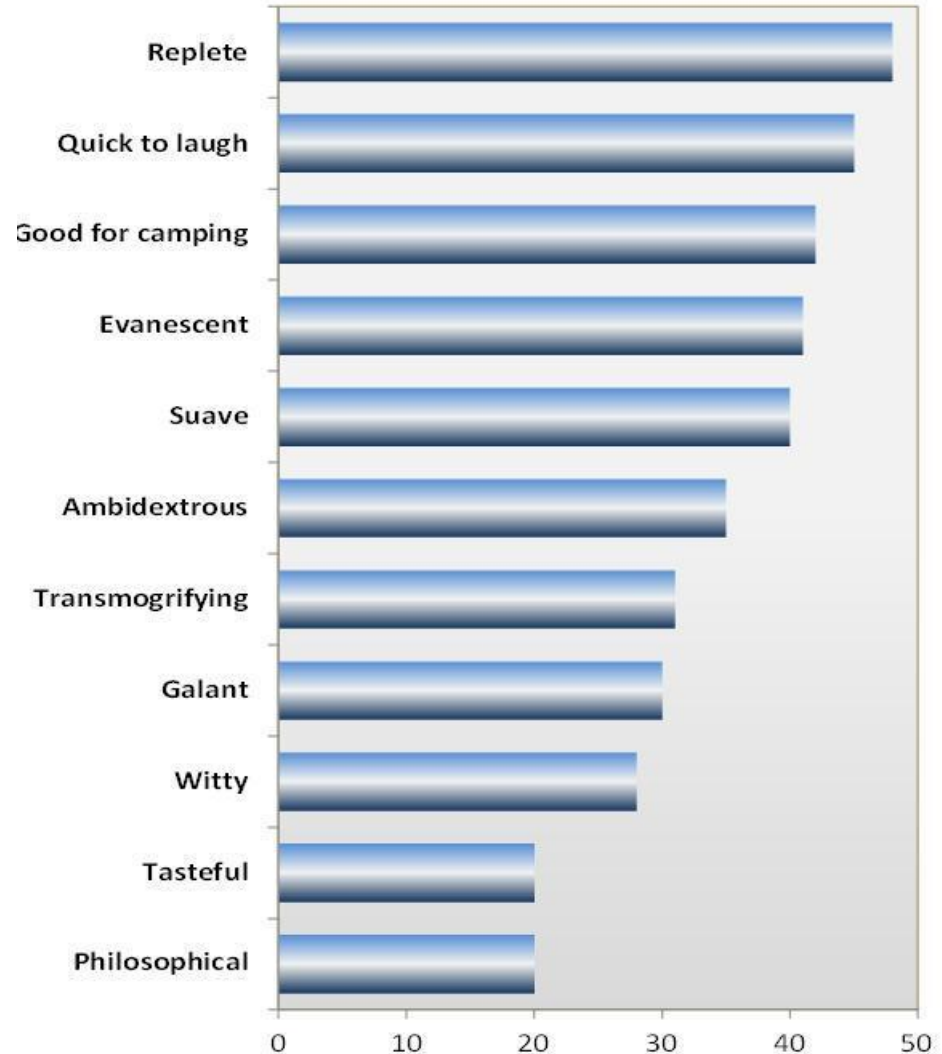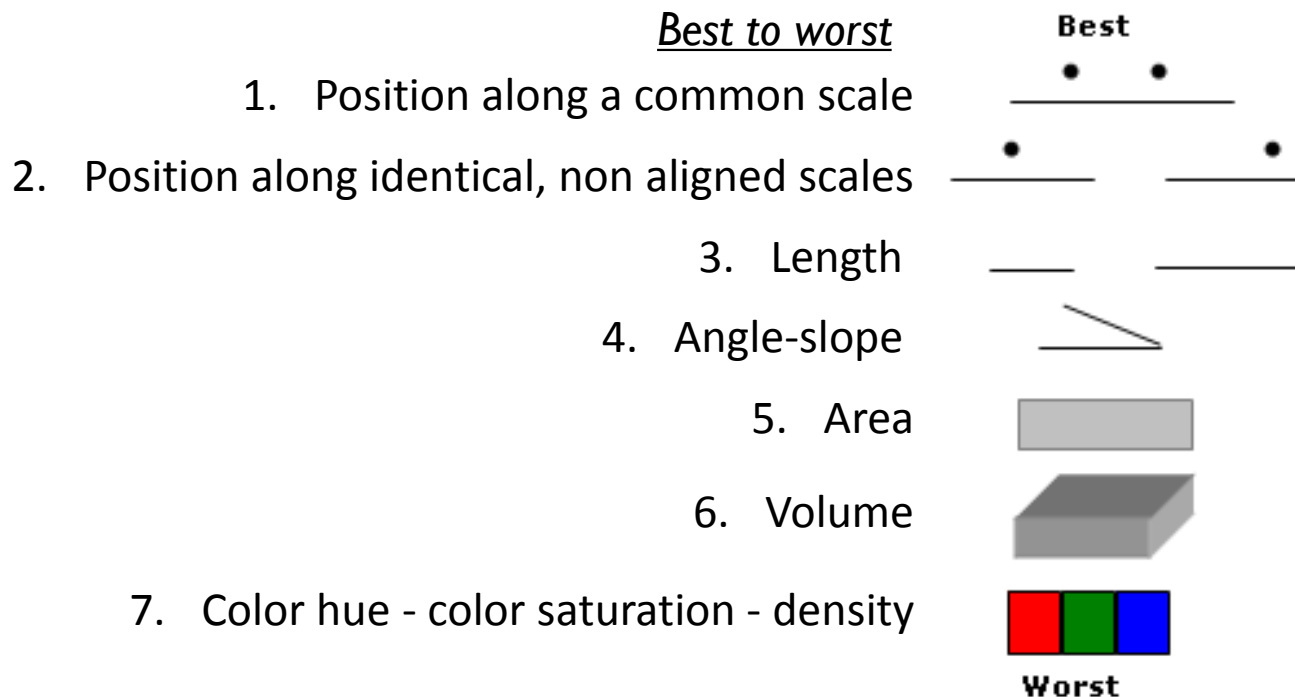
Using how people perceive

Understanding perceptual tendencies improves charts

- We can use knowledge of how we perceive to make charts better

- For instance, some charts are optical illusions

  - Pies in particular

  - Stacked bars often deceive

    - Nonetheless, experts are divided

      - Some say they make good replacements for pie charts

- Following we highlight areas of strong consensus about how people perceive information

  - Still, most "less preferred" chart types can be used at times—carefully—to good effect

  - We say "never" only once, and mean it only twice
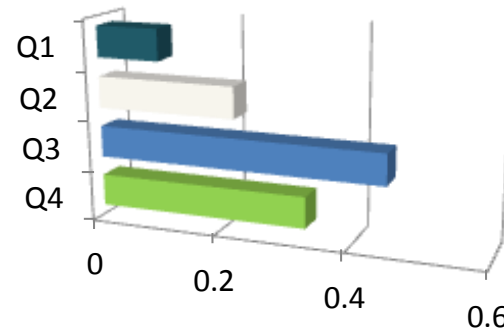
Converge Analytic
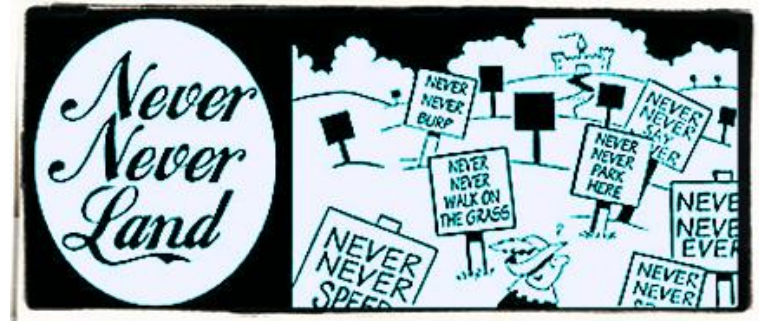
Position along a common scale is easiest for people to compare; color hue/saturation/density hardest

- Actual experiments show surprising results (Cleveland, 1984)
  - In comparing relative magnitude, the lines and bars that we tend to use are good, but still not easiest to compare
  - Color and hue are worst

<div align="center">

Best to worst

1. Position along a common scale

2. Position along identical, non aligned scales

3. Length

4. Angle-slope

5. Area

6. Volume

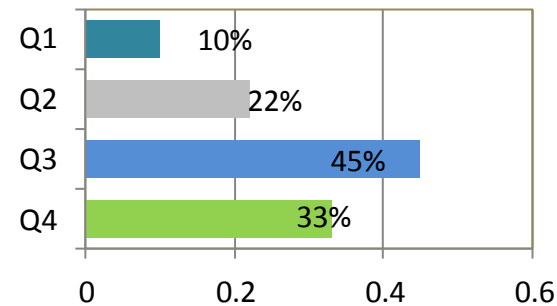7. Color hue - color saturation - density

</div>

Converge Analytic

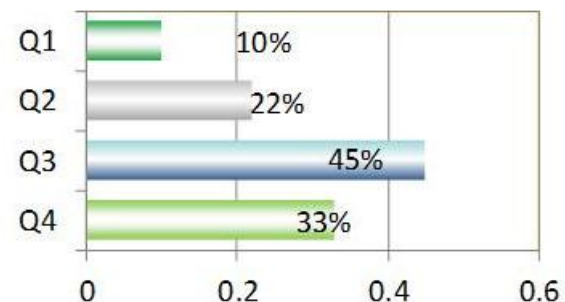## Most authorities hate pie charts, comparing areas, and especially fake 3-D

- Much that you need to know about good usage in charts is in the headline
  - Even if Excel loves fake 3-D charts

Too much ink! Distorted Too much junk

- Experts are uniform in seeing these as odious—
  - They can distort relationships
  - They violate accepted standards for avoiding chart junk
  - They have too much ink to data

Much less ink— very low junk

- Bars with fake highlights actually have less ink than their solid counterparts
  - Choice between these two seems a matter of taste
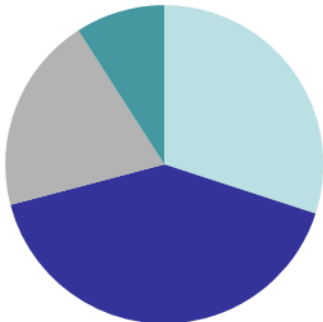

Even less ink— Still very low junk

Converge Analytic
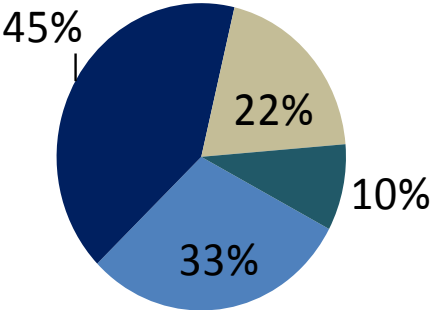
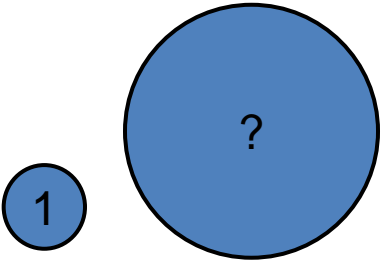# Reasons authorities usually hate comparing areas and pie charts[1]

- Use a pie only if it has a few slices—but maybe not ever
  - Really try to lose 3-D pie charts
  - They are optical illusions
- The relative sizes of areas, circles in particular, are hard to compare
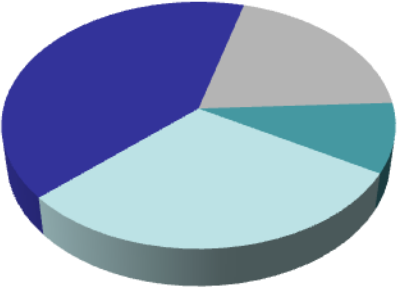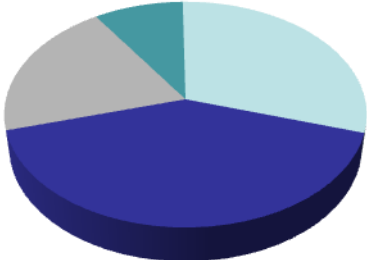

How big are these slices?

45%

22%

10%

33%

Not really? (Really)

1

?

How much bigger is the big one?[2]

All four pies have the same proportions (Really)

[1]*Some say some pies are OK, with a few large slices*

[2] *Three times the diameter or about 7 times the area of the small one*

Converge Analytic

Bad news: Most experts say stacked bars deceive us

- Rationale for not liking stacked bars—
  - No common baseline or point of reference for any groups after the first
  - Therefore, we find it difficult to assess relative magnitudes of all but the first series
    - Maybe that's why this man is frowning
  - But what's the alternative?

Converge Analytic
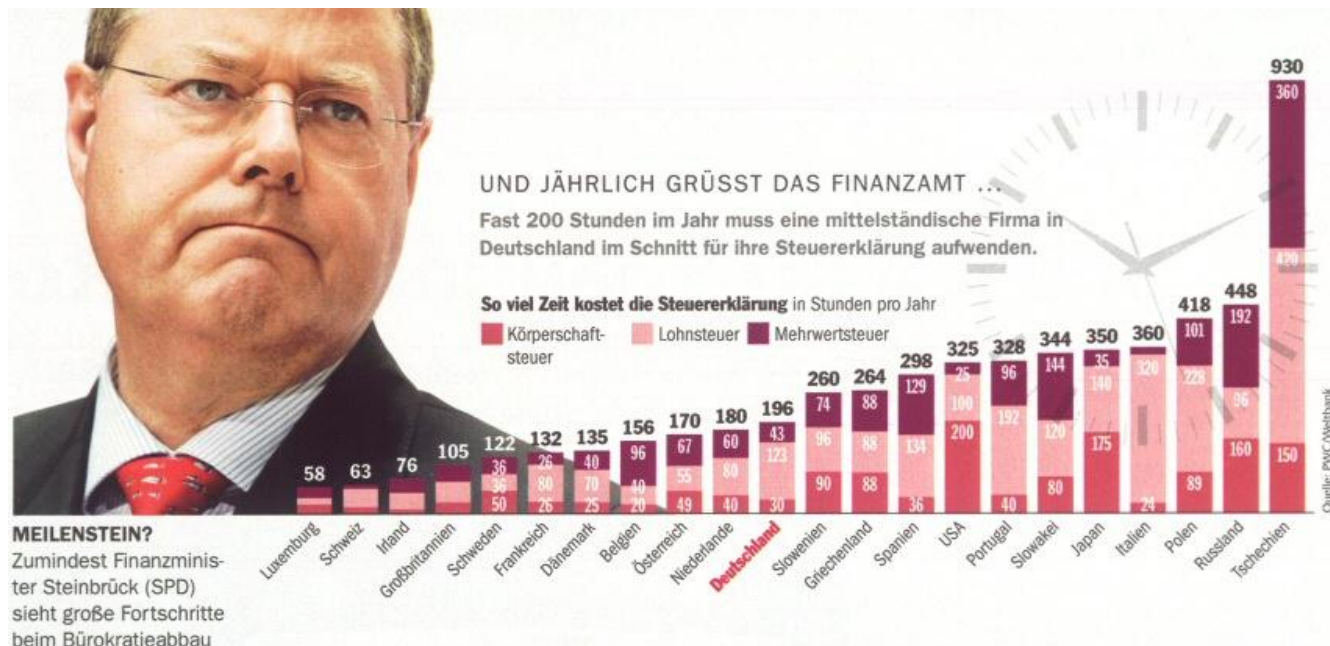
Replacing stacked bars: (1) clustered bars in "trellis charts" (bottom)

Converge Analytic
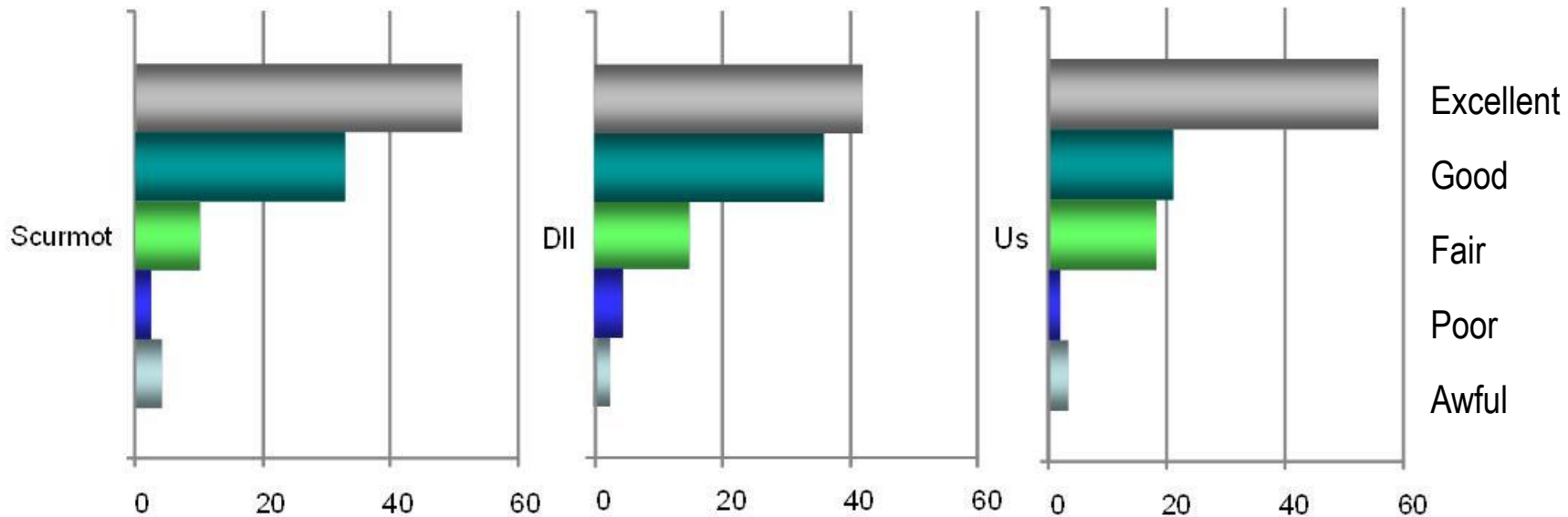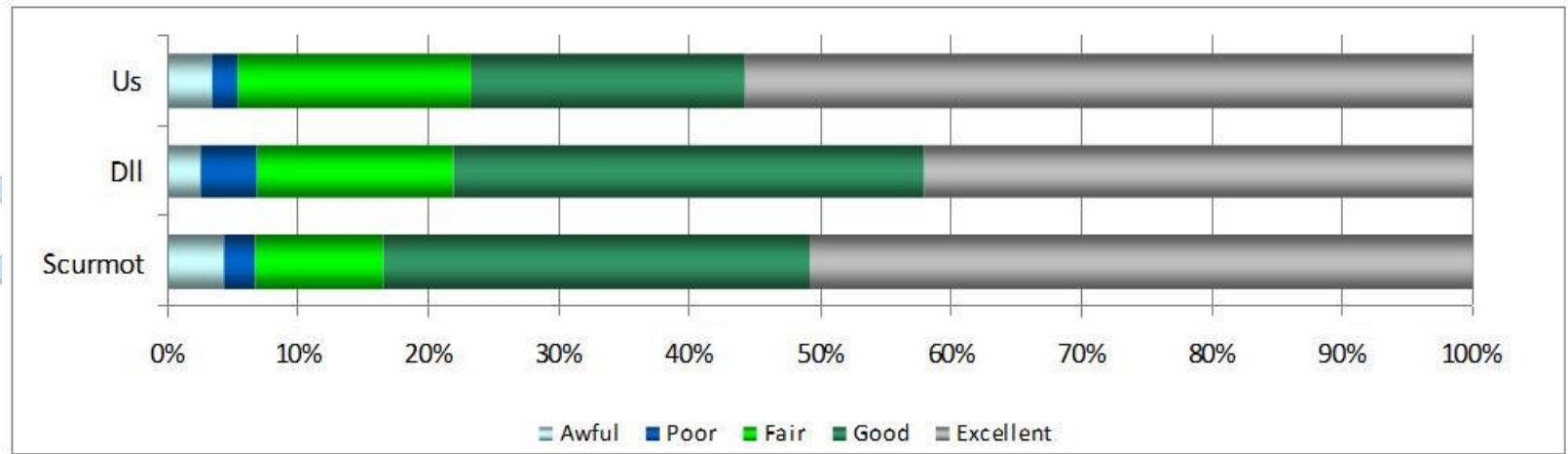
Replacing stacked bars: (2) Aligned rather than stacked bars
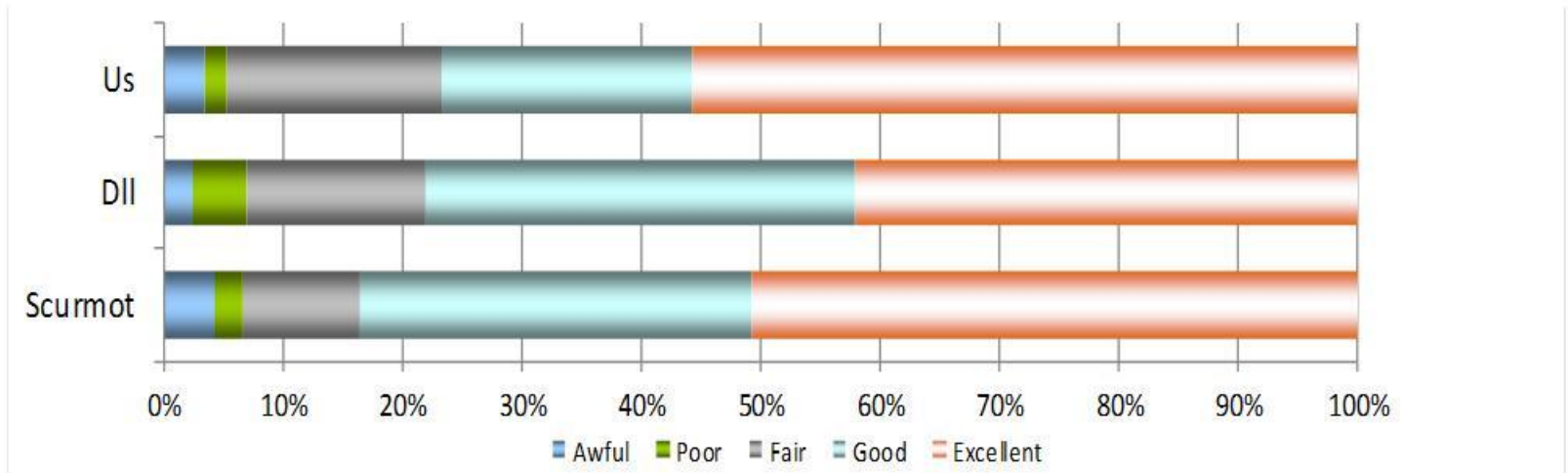
Aligning bars makes differences in categories clearer

Converge Analytic
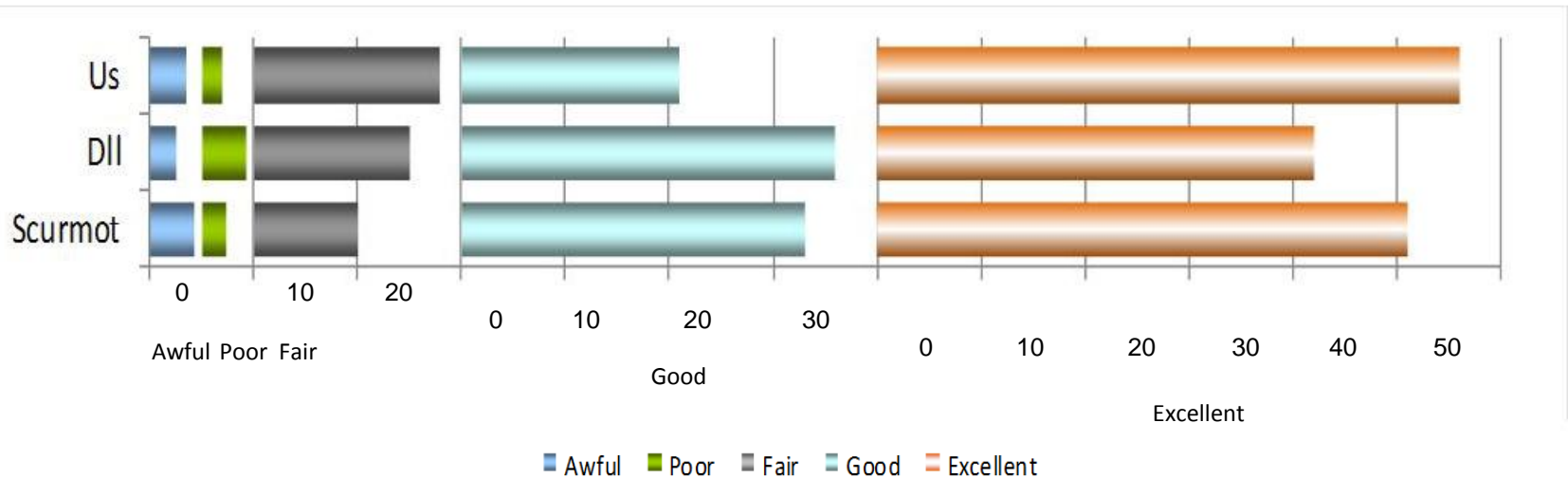
Cut legends if you can (and more on the violence fake 3-D does)

- Legends can distract and confuse
  - If you are clever many can be eliminated
- Note that we have avoided using a legend by the simple expedient of labeling the line series (on both charts)
- The chart to the right is awful even while avoiding a legend
  - It's the same data that the line chart shows so easily
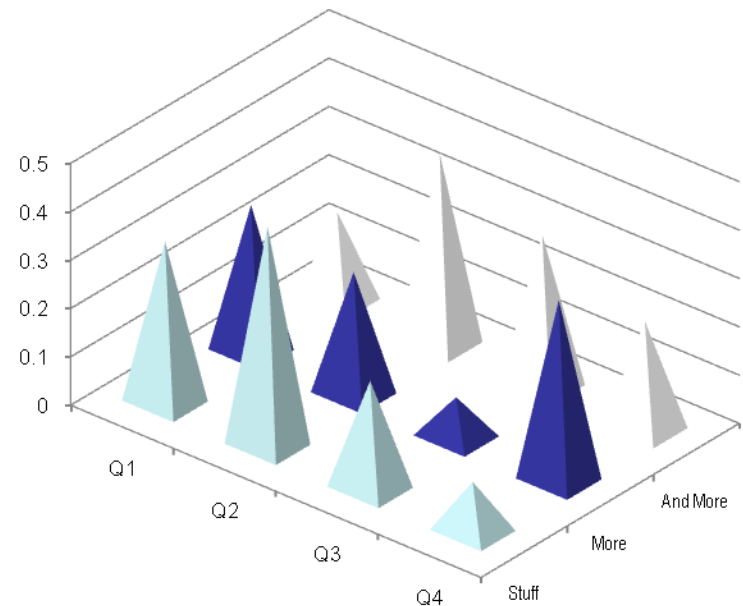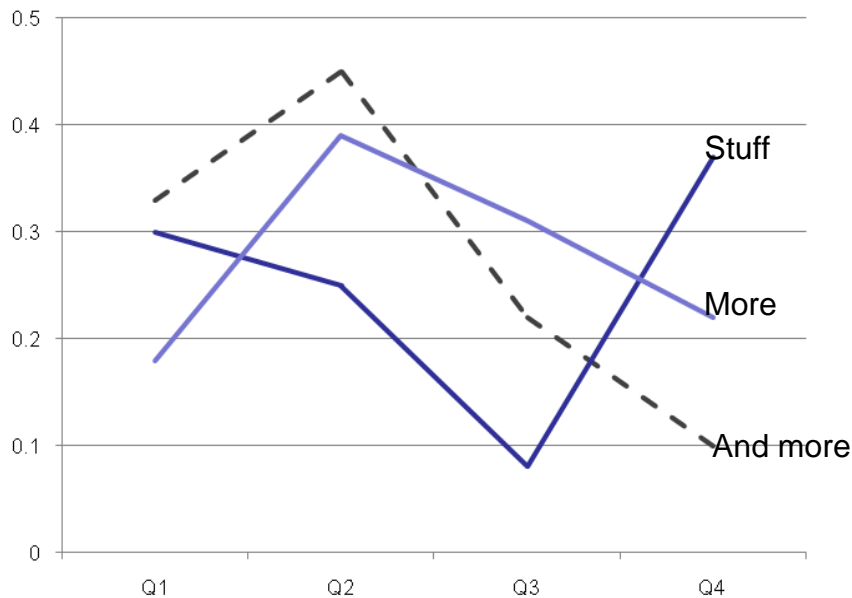
Use what people can process at a glance including bolding for more intensity; italics for direction

- People see some things at a glance; watch for these in particular—
  - Difference in intensity
  - Motion or flicker
  - Size
  - Enclosure
  - Direction or orientation

How many fives?

1345143910150423594
2468539012424532110
4648390215342210190
6234121515320891023

How many fives?

134**5**143910**5**0423594
2468**5**39012424**5**32110
464839021**5**342210190
6234121**5**1**5**320891023

Bolding makes it much easier to see quickly how many fives.
You process bolding *pre-attentively*
Enclosing the fives works as well
Italics and changing size nearly as well

Converge Analytic

Good aspect ratio helps horizontal charts communicate:
Many experts recommend "banking to 45°"

- The bottom chart layout actually is better
- The slopes are closer to 45°, allowing us to see that sunspot patterns *often rise faster than they fall*
- People are particularly good at judging angles around 45°
  - We can get finer distinctions by aiming for this angle in charts
  - In this case, height is not a plus

Sunspot Trend (1750 - 1924) Aspect Ratio = 1.000

Sunspot Trend (1750 - 1924) Aspect Ratio = 0.055
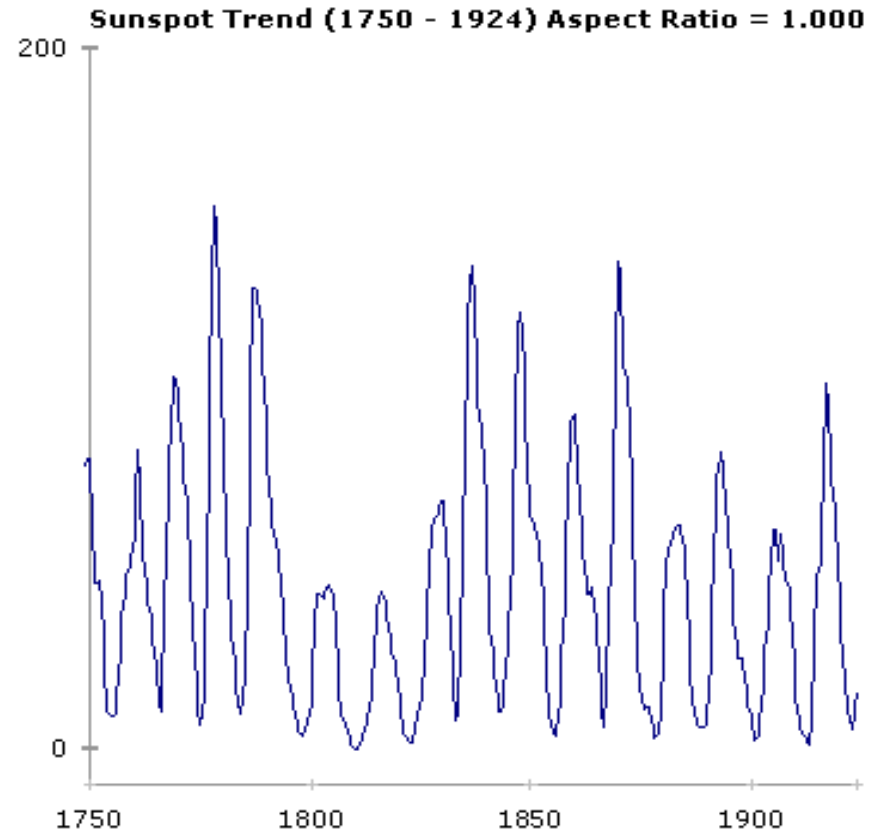
Keeping scales true makes comparisons easier for audiences

- The use of different scales along a common axis makes it hard to compare actual values

- This makes it look like industrial consumption is rising by as many units as total consumption

- The aspect ratio is not too good, either—more like 15% than 45%

  - This chart was put on the Web by someone claiming expertise

US Oil Use By Sector: 1950 - 2004
(Million Barrels/ day)

Oil Use - Mill Barrels/Day

Total — 20.0
6.3

Transportation — 13.6
3.4

Industrial — 5.1
1.8

Resid & Com'l — 1.3
1.1

Source: DOA, EIA - Annual Report - 2005: Tables: 5.13a - d

1950   1960   1970   1980   1990   2000
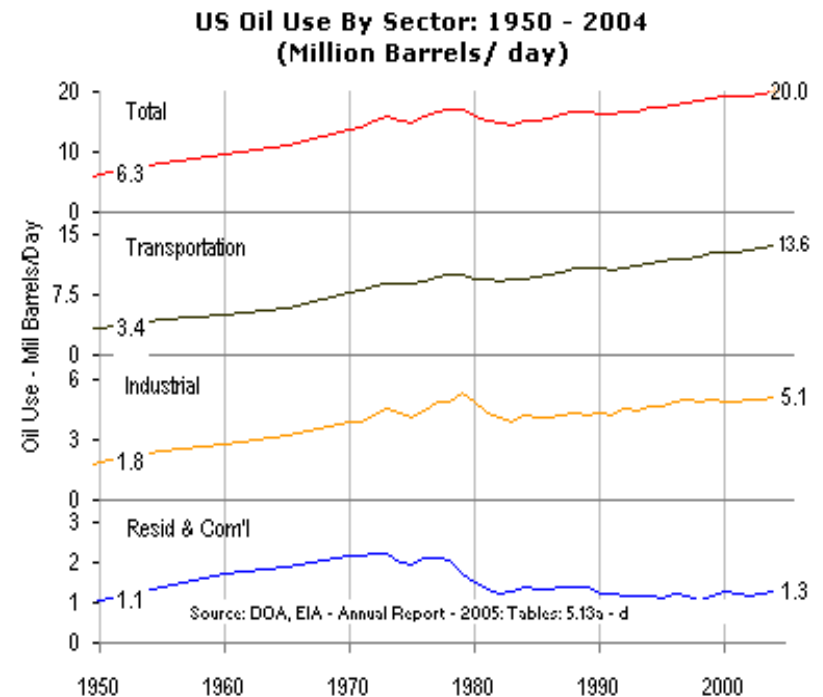
Be careful where you get advice

Converge Analytic

Increasing readability: Use placement to guide the reader's eye

- Text charts break the simplicity rule—but if you must use them, they can be better
  - Right aligning text along vertical charts makes them easier to read
  - Light lines can help keep the numbers in charts straight
  - Simple frames help comparisons as do sizing and bolding key items

Sales/Acct Rep/Relationship (Typical chart)

	Impact	Top 2 Box Perf
Is committed to exceeding my requirements	.076	.28
Treats me like a business partner	.059	.32
Is easy to do business with	.058	.32
Speed with which I receive price quotes	.038	.39
Speed with which I can reach them when I need help	.035	.42
Listens to my needs	.035	.33
Help me select products and services	.034	.40
Keeping me informed	.030	.29
Treating me like a valued customer	.030	.46
Overall technical knowledge and expertise	.029	.45
Speed of answering my questions	.027	.38
Understanding of my business needs	.026	.39
Understanding of product and service offerings	.023	.45

Sales/Acct Rep/Relationship (Better)

	Impact	Top 2 Box Perf
Is committed to exceeding my requirements	**.076**	.28
Treats me like a business partner	**.059**	.32
Is easy to do business with	**.058**	.32
Speed with which I receive price quotes	.038	.39
Speed with which I can reach them when I need help	.035	.42
Listens to my needs	.035	.33
Help me select products and services	.034	.40
Keeping me informed	.030	.29
Treating me like a valued customer	.030	**.46**
Overall technical knowledge and expertise	.029	**.45**
Speed of answering my questions	.027	.38
Understanding of my business needs	.026	.39
Understanding of product and service offerings	.023	**.45**

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Creativity can enhance your message

- I wish I had thought of this. . .

"Academic" Salaries
Actual average and median salaries at U.S. Doctoral-granting Universities

| Role	Salary
University President/CEO	$320,616
Provost	$242,570
Deans	$189,217
Tenured Professors (Male)	$95,199
Tenured Professors (Female)	$86,311
Un-tenured Professors (Male)	$70,055
Un-tenured Professors (Female)	$65,692
Grad Students	$17,784
Football Coaches (for real)	$1,057,305

Legend: ■ Male ■ Female
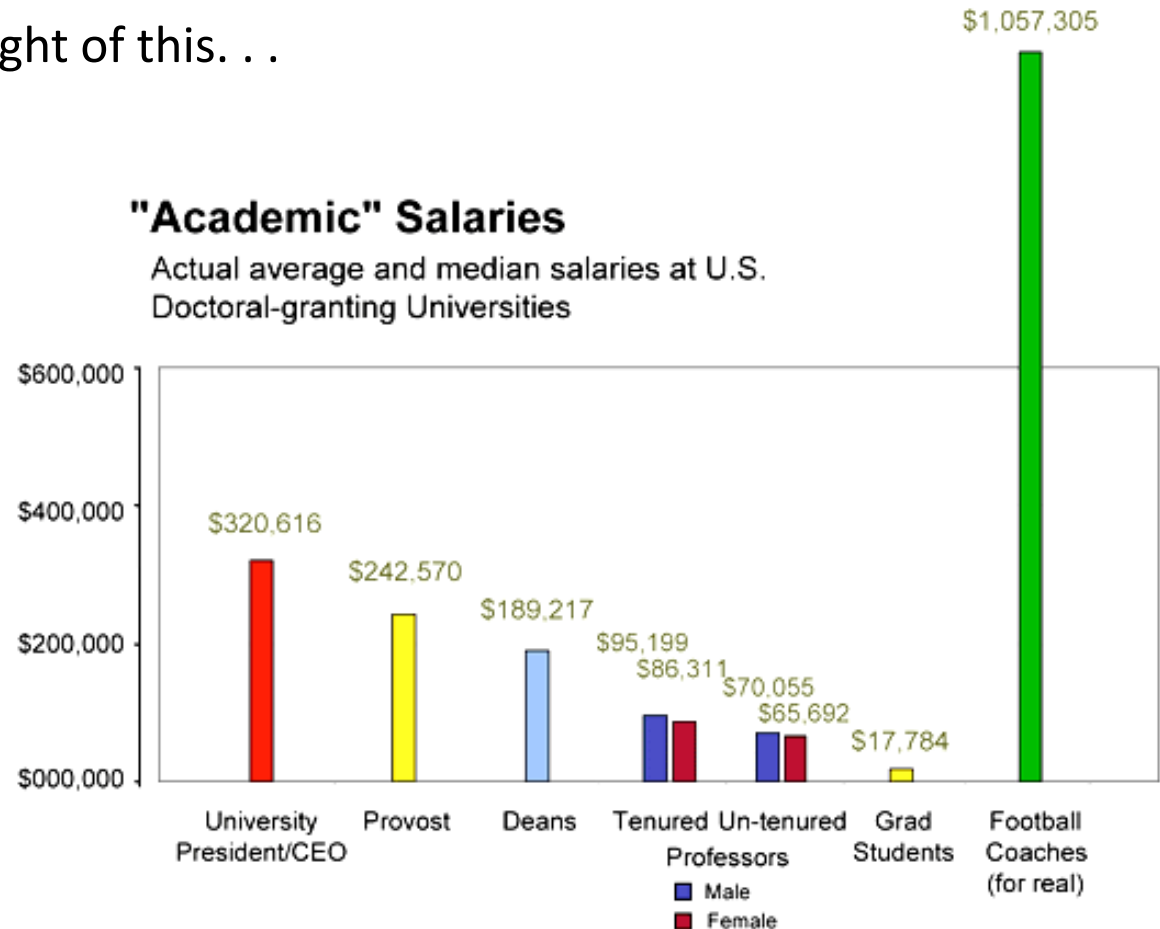
Notes: Administrator figures are medians salaries, the rest are averages. All figures in 2008 dollars. Sources: College and University Professional Association for Human Resources 2005 Survey; American Association of University Professor: 2007 Survey; The Chronicle of Higher Education 2001 Survey of Graduate Assistants; USA Today Survey of Div. I-A College Football Coaches Compensation 2007
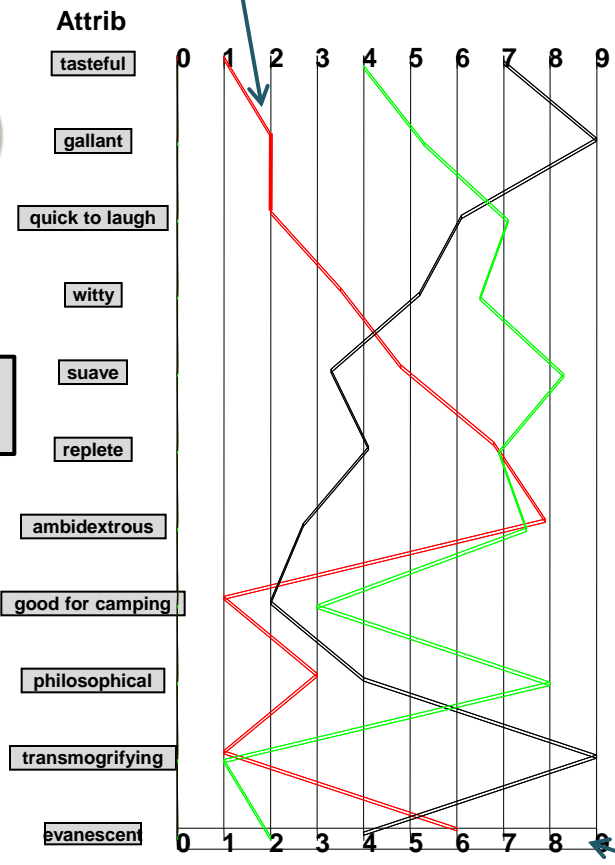
Putting it together

All together: Moving away from disorganization, chart junk, needless legends and obscure meaning

- How many items do you see that could use some improvement?
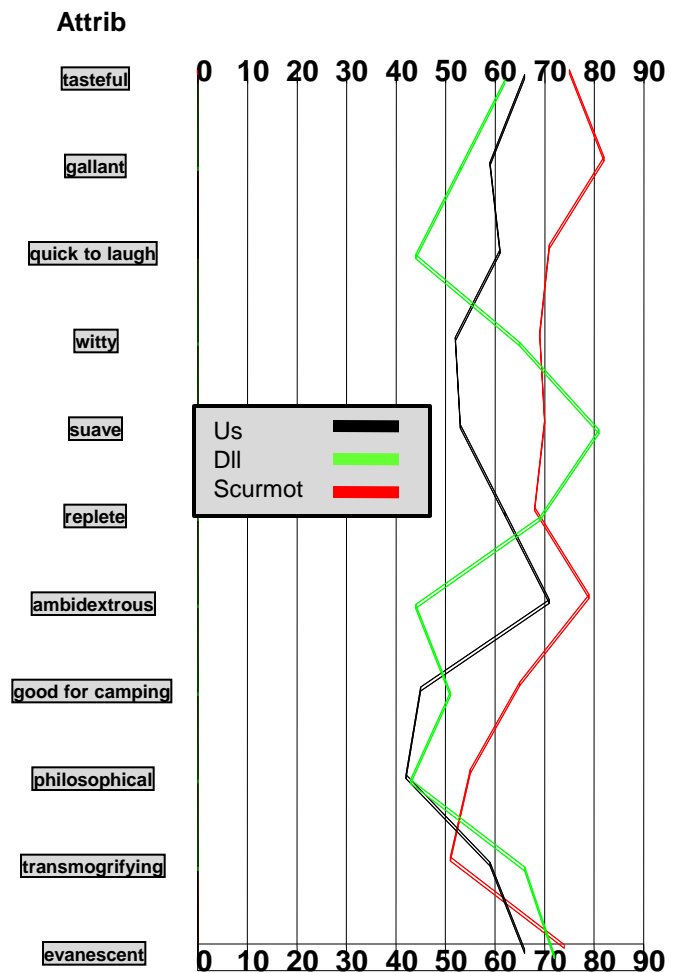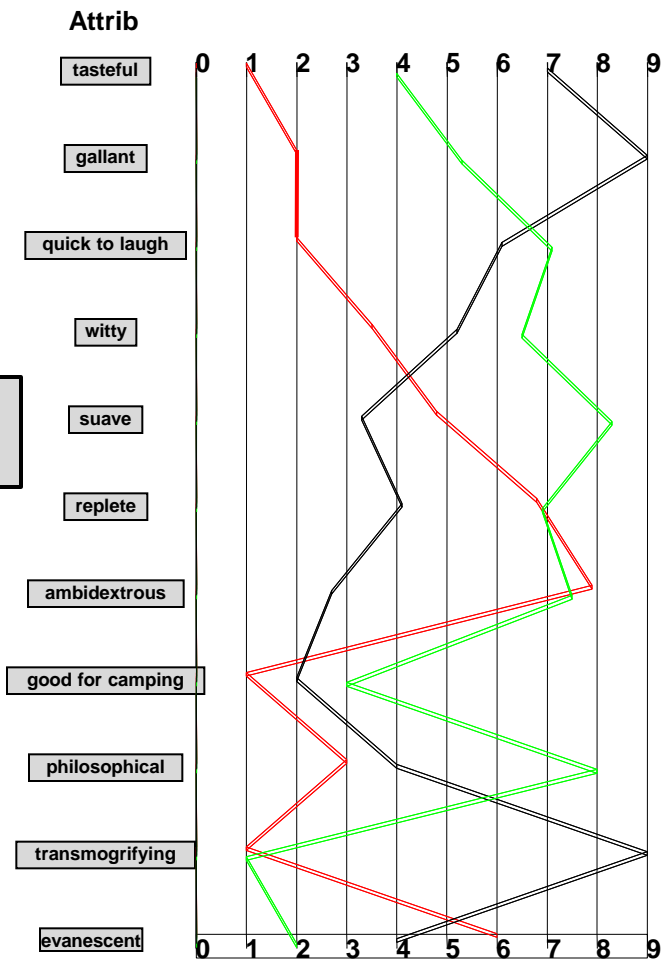
Here are some areas for improvement: Did we miss anything?

1 Lack of order is confusing. We cannot compare these series

2 Labels are defeated by small size, useless shading and borders and poor alignment—doubling them also hurts
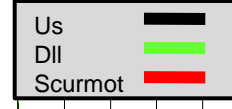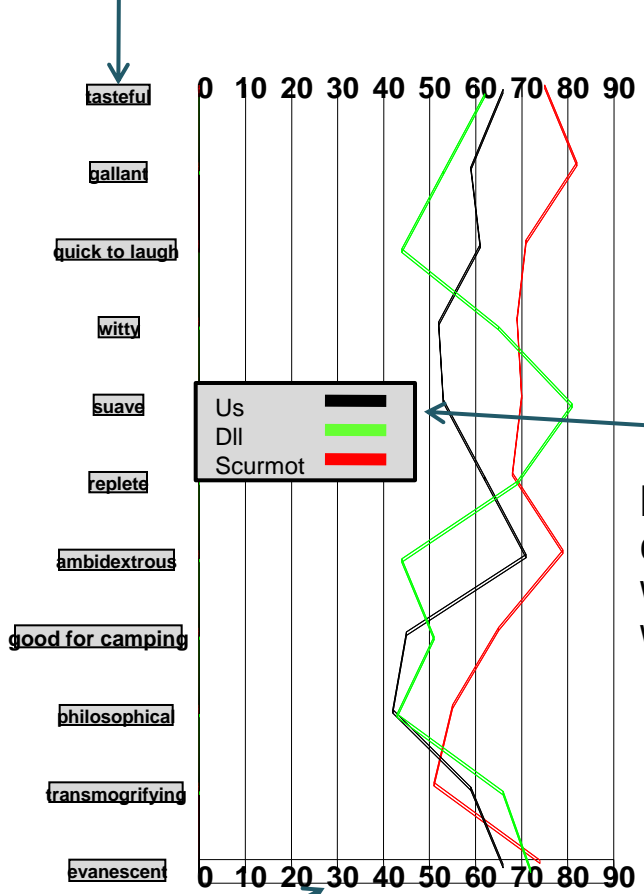
5 Legends add to the confusion (which would matter more with a better layout)

Bottom 2 box

Top 2 box

3 Boxing the scales (intended or not) adds junk, as does doubling scales top and bottom

4 Inconsistent scaling makes the bottom 2 boxes look bigger than the top 2

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We can move to clarity by arranging, cleaning and eliminating legends

This indeed shows the same data as in the paired line charts
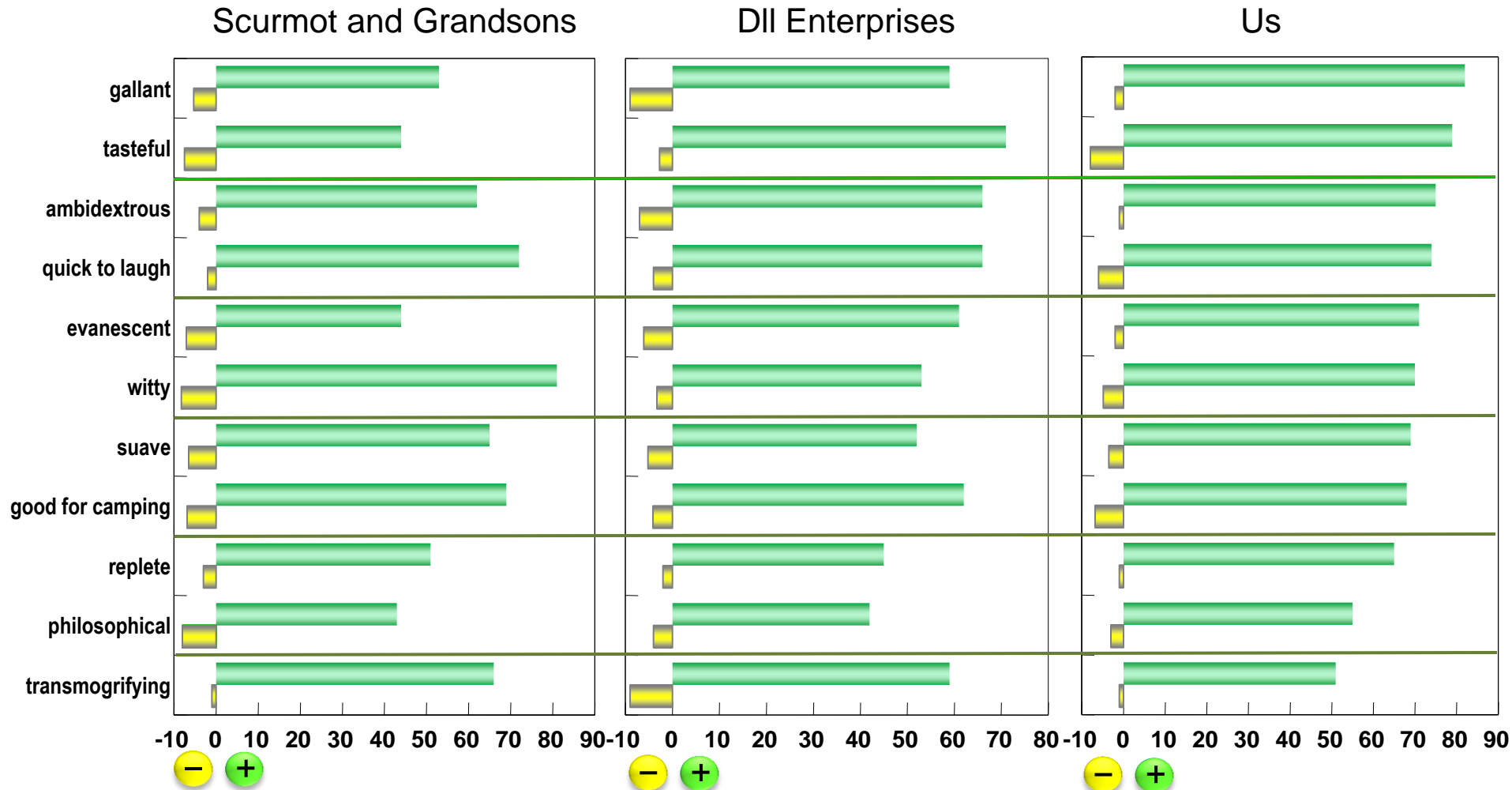
Summary: Do the hard work and simplify

- Surprisingly few people like to read or process visually
  - Simplicity is better
- If it is complex, we need to build up to the difficult picture
- We need to organize graphics to follow the main point discussed
- Keeping it easy for the reader is hard work for the author, but work with benefits for all [1]

[1] Let's bypass that deep discussion of what happened to this in the arts and sciences in the 20th century

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Try not to fool or frustrate

- Real authorities consider fake 3-D and especially 3-D pies vile
  - For the good reason that they usually are optical illusions
  - Typically try to avoid them
- A few proven tricks can help readers process information
  - Control of text placement and aspect ratio help communicate more clearly
  - Bolding and sizing can highlight key figures
  - Careful use of lines can help guide the eye

A more amusing illusion

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Plan for ambushes by equipment—especially if you are live

- Keep text and charts legible for cranky equipment
  - Most equipment is cranky in public shows and sometimes in private also
  - Dark areas including type can pose problems once you are off the Web
    - And sometimes even on the Web
      - Devices continue to get smaller

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Do not over-decorate—and mostly recall it is your audience's show

- We recommend an intermediary path on chart/slide decoration
  - Some argue that all decoration is bad and too distracting
  - Others argue that audiences will not pay attention to anything too plain
  - Still, we need to stay always vigilant against the "chart junk" that PowerPoint seems to attract magnetically
- Strictures, rules and guidelines are useful, but most of all, approach problems creatively "to instruct and delight"

Instructed and delighted

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End

Questions? Comments?

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Key references

- Apologies to other booksellers for the Amazon links

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