

Visual Explainers

Maneesh Agrawala

**CS 448B: Visualization
Fall 2021**

with material from Matthew Conlen and Jessica Hullman

1

The New York Times



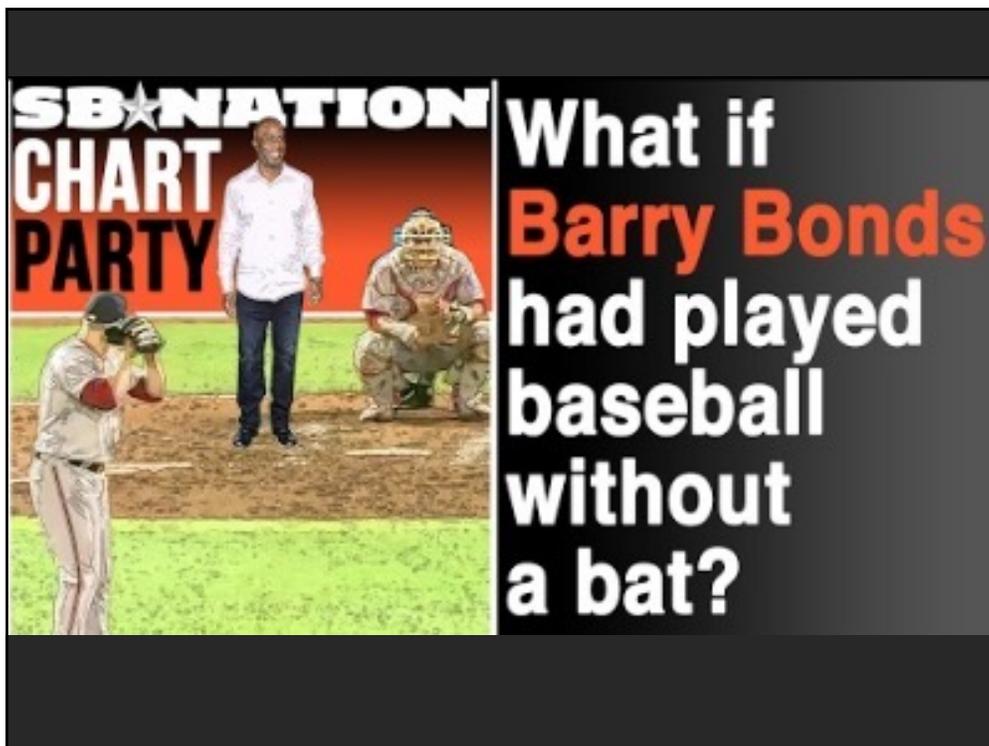
See How the Dixie Fire Created Its Own Weather

This year's largest blaze generated powerful storm clouds. We show you in 3-D.

By Nadja Popovich, Noah Pisner, Nicholas Bartzokas, Evan Grolbjan,
Daniel Mangosing, Karthik Patanjali and Scott Reinhard

Oct. 20, 2021

2



3



4

Principles

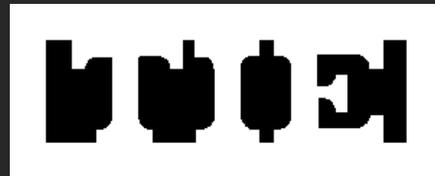
- figure/ground
- proximity
- similarity
- symmetry
- connectedness
- continuity
- closure
- common fate
- transparency

5

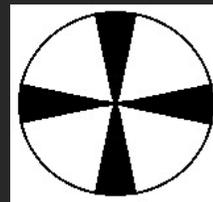
Figure/Ground



Ambiguous



Principle of surroundedness



Principle of relative size

<http://www.aber.ac.uk/media/Modules/MC10220/visper06.html>

6

Figure/Ground



Ambiguous

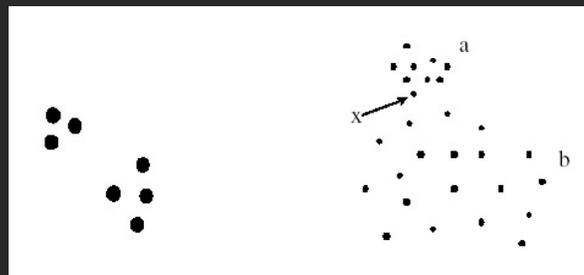
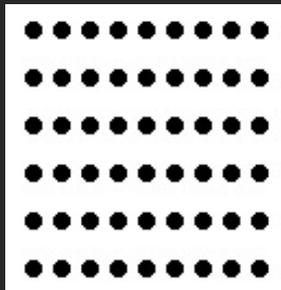
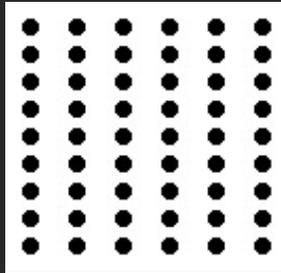


Unambiguous

<http://www.aber.ac.uk/media/Modules/MC10220/visper06.html>

7

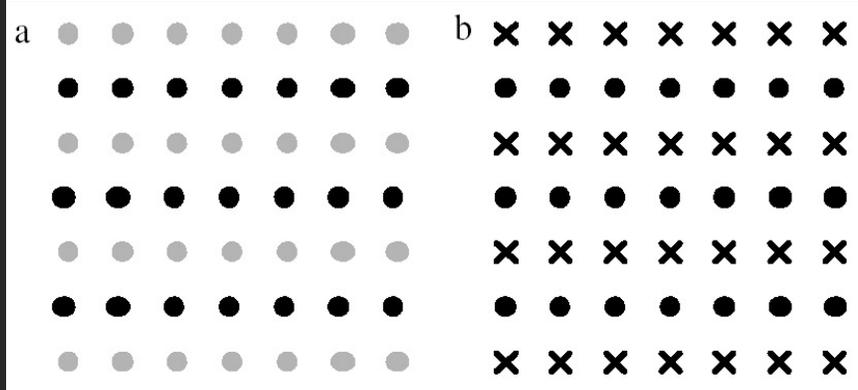
Proximity



[Ware 00]

8

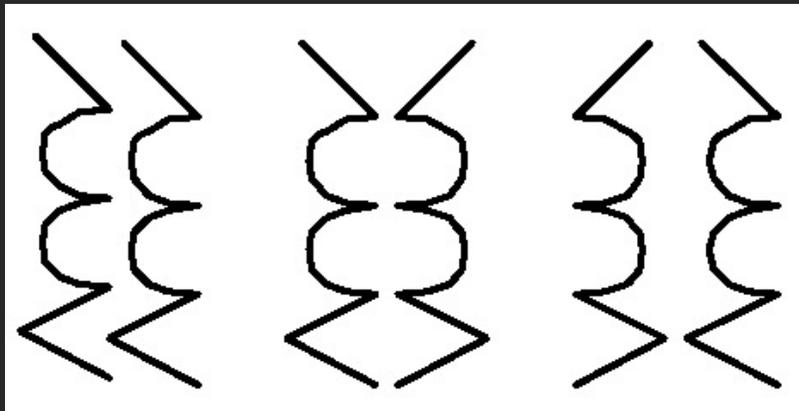
Similarity



Rows dominate due to similarity [from Ware 04]

9

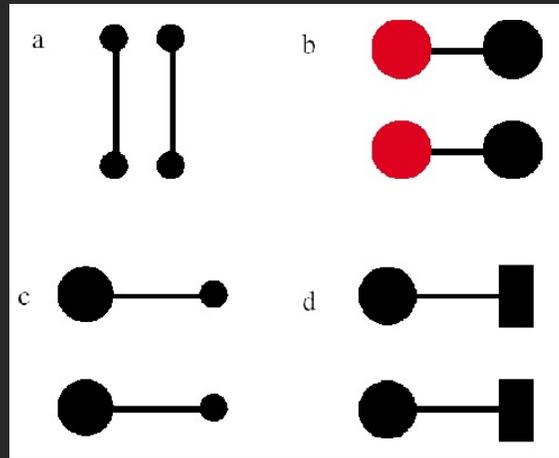
Symmetry



Bilateral symmetry gives strong sense of figure [from Ware 04]

10

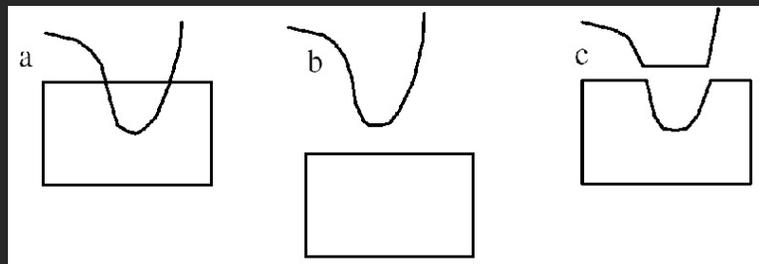
Connectedness



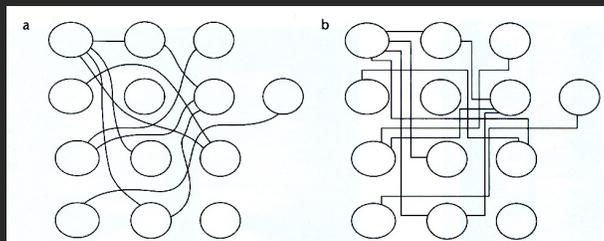
Connectedness overrules proximity, size, color shape [from Ware 04]

11

Continuity



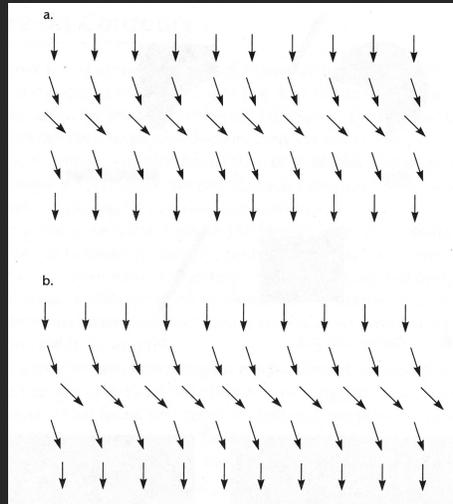
We prefer smooth not abrupt changes [from Ware 04]



Connections are clearer with smooth contours [from Ware 04]

12

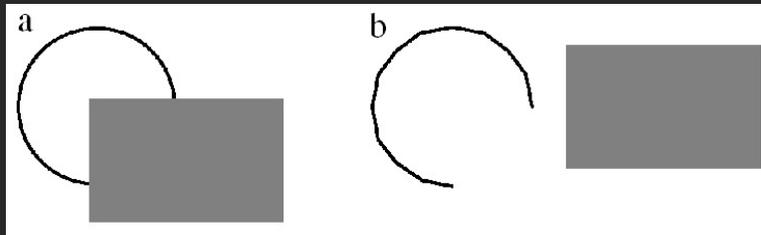
Continuity: Vector fields



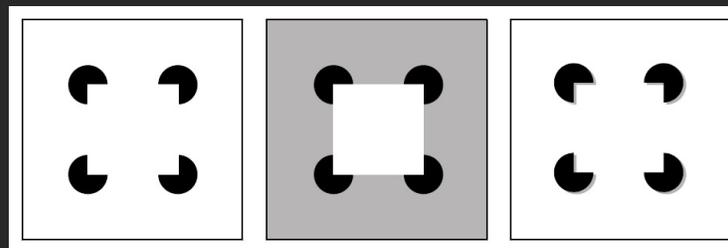
Prefer field that shows smooth continuous contours [from Ware 04]

13

Closure



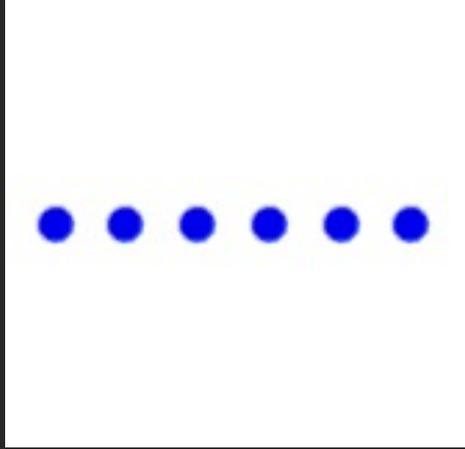
We see a circle behind a rectangle, not a broken circle [from Ware 04]



Illusory contours [from Durand 02]

14

Common fate



Dots moving together are grouped

<http://coe.sdsu.edu/eet/articles/visualperc1/start.htm>

15

Transparency



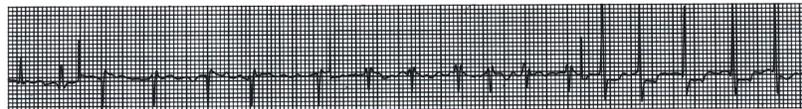
Requires continuity and proper color correspondence [from Ware 04]

16

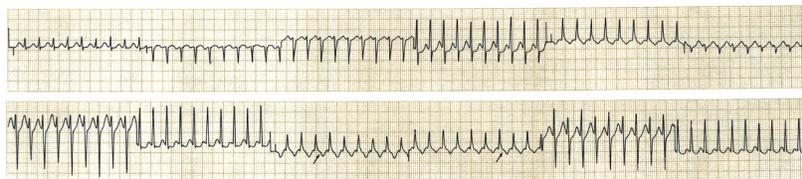
Layering and Small Multiples

17

Layering: Gridlines



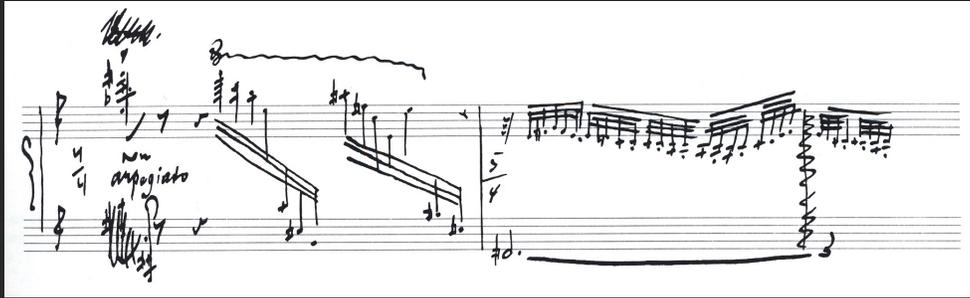
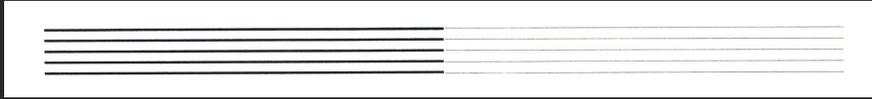
Signal and background compete above, as an electrocardiogram trace-line becomes caught up in a thick grid. Below, the screened-down grid stays behind traces from each of 12 monitoring leads:⁴



Electrocardiogram tracelines [from Tufte 90]

18

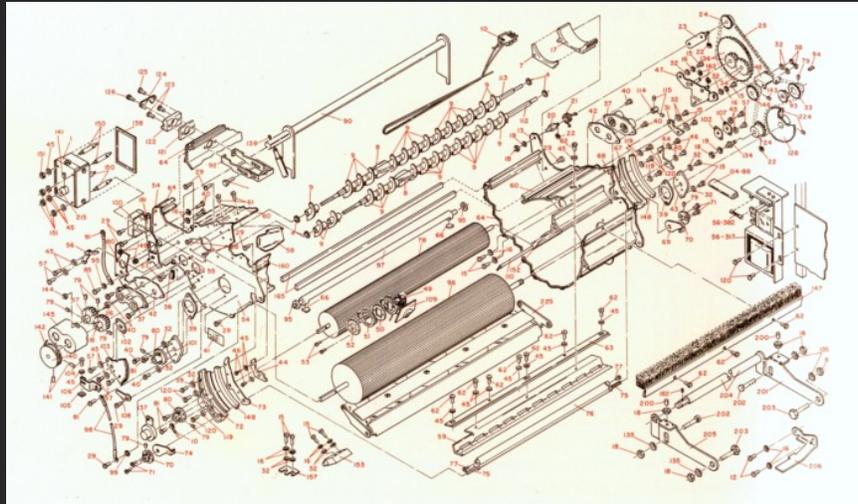
Layering: Gridlines



Stravinsky score [from Tufte 90]

19

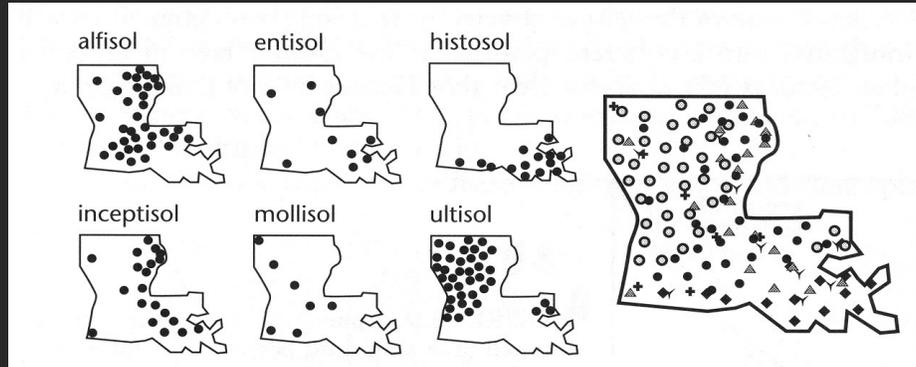
Layering: Color and line width



IBM Series III Copier [from Tufte 90]

21

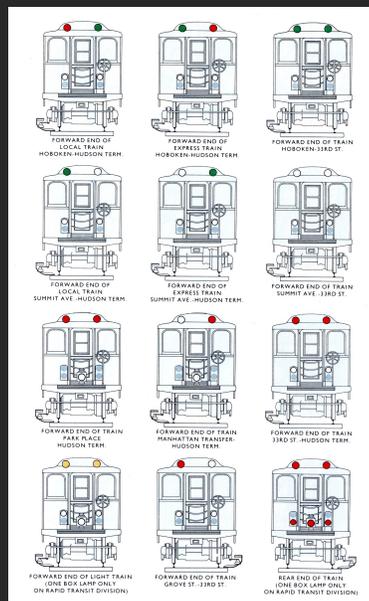
Small multiples



[Figure 2.11, p. 38, MacEachren 95]

22

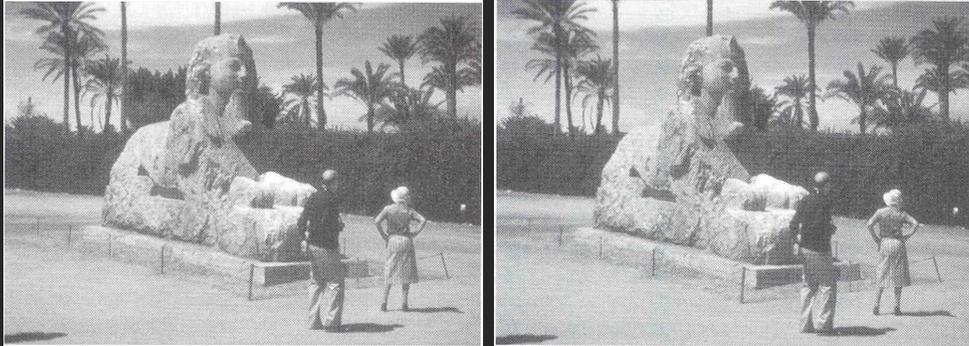
Small multiples



Operating trains. Redrawn by Tufte to emphasize colored lights. [from Tufte 90]

23

Change blindness



[Example from Palmer 99, originally due to Rock]

24

Change detection



25

Change detection



26

Rensink's demonstration



<http://www.csc.ncsu.edu/faculty/healey/PP/index.html>

27

Summary

Choosing effective visual encodings requires knowledge of visual perception

Visual features/attributes

- Individual attributes often preattentive
- Multiple attributes may be separable, often integral

Gestalt principles provide higher level design guidelines

We don't always see everything that is there

28

Announcements

29

Assignment 3: Dynamic Queries

Create a **small** interactive dynamic query application similar to HomeFinder, but for restaurants data.

1. Implement interface
2. Submit the application and a short write-up on canvas



Can work alone or in pairs
Due before class on **Oct 25, 2021**

30

Instructions: You can use the various filters here including restaurant name (starting few characters), city, zipcode, and inspection results.

Restaurant Name:

City: ALVISO CUPERTINO LOS ALTOS LOS ALTOS HILLS MOUNTAIN VIEW PALO ALTO SAN JOSE SANTA CLARA STANFORD SUNNYVALE

Zipcode: 10017 28217 90487 94 94022 94024 94028 94031 94036 94039 94040 94041 94043 94045 94065 94080 94091 94095 94096 94087 94088 94089 94091 94102 94104 94121 94301 94302 94303 94304 94305 94306 94309 94503 94559 94590 94603 94605 95002 95014 95015 95050 95051 95054 95086 95104 95129 95134 95762

Inspection Grade: Pass Conditional Pass Fail Closure Not Available

Inspection Score Range: 0 - 100

The red circle indicates regions within 3 miles from point A and the green circle indicates regions within 3 miles from point B. You can adjust their positions by dragging on the interior of the circles and adjust their sizes by dragging on their circumference.

31

Discussing notebooks

Stay tuned for extra office hours

We are happy to discuss your code

- But, do **not** publish your notebook
- Instead **enable link sharing in Observable** and share the link with us privately through Slack

32

Visual Explainers

33

Topics

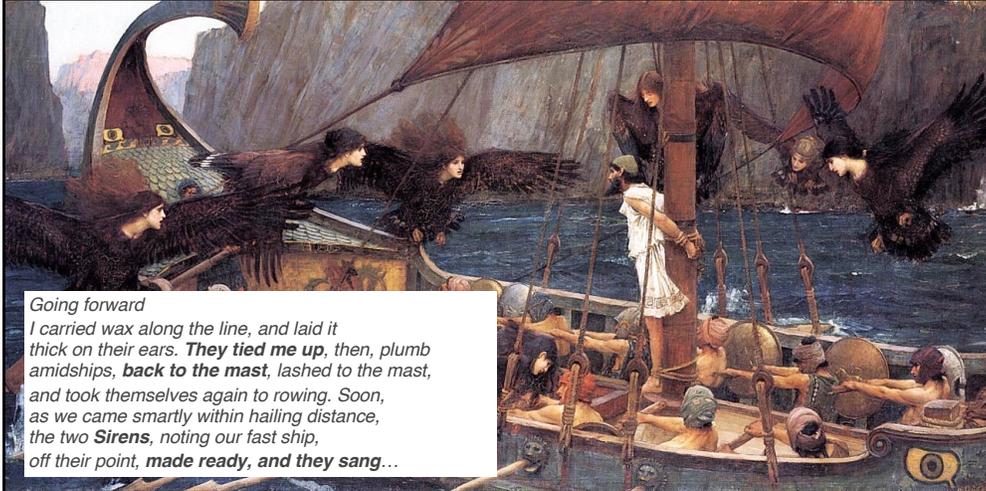
1. Storytelling
2. Design space of narrative visualization
3. Interactive documents
4. Chart sequences

34

Storytelling

35

As ancient as mankind



Going forward
I carried wax along the line, and laid it
thick on their ears. **They tied me up**, then, plumb
amidships, **back to the mast**, lashed to the mast,
and took themselves again to rowing. Soon,
as we came smartly within hailing distance,
the two **Sirens**, noting our fast ship,
off their point, **made ready, and they sang...**

36

All media tell stories

PEOPLE TELL STORIES

WORDS TELL STORIES

IMAGES TELL STORIES

COMICS TELL STORIES

MOVIES TELL STORIES

VISUALIZATIONS TELL STORIES

37

Narrative Storytelling

narrative (n): An account of a series of events, facts, etc., given in order and with the establishing of connections between them

"... require[s] skills like those familiar to movie directors, beyond a technical expert's knowledge of computer engineering and science."

- Gershon & Page '01

38

August 26, 2010

Generals Wary of Move to Cut Their Ranks

By GINGER THOMPSON and THOM SHANKER

WASHINGTON — Maj. Gen. Paul D. Eaton, a retired Army officer, is familiar with the perks and pitfalls of power, having commanded tens of thousands of troops at Fort Benning, Ga., managed budgets exceeding \$2 billion in Iraq, and overseen layers upon layers of staff members who helped manage both his professional duties and his personal life.

He has experienced the full range of lifestyles that come with military leadership, living at one point in an elegant antebellum mansion, and at another, with eight other officers crowded in a marble bathhouse behind one of Saddam Hussein's old palaces.

When he traveled, he was occasionally able to justify the use of military aircraft, but most times, he said, he flew coach. And today he lives on a pension worth 75 percent of his military salary, with health benefits that cover everything except dental and eye care for himself and his wife.

"We are well compensated, and we live very comfortable lives," General Eaton said, referring to the military's most senior leaders. "But when you look at all the things going on around a general, the nation is getting a very, very high return on its money."

Not everyone at the Pentagon agrees. Two weeks ago, Defense Secretary Robert M. Gates announced a sweeping effort to improve efficiency that, among other things, takes aim at the military's sacrosanct corps of generals and admirals, ordering his staff to cut at least 50 positions, and making clear that he would be happier if they cut more.

39

August 26, 2010

Generals Wary of Move to Cut Their Ranks

By GINGER THOMPSON and THOM SHANKER

WASHINGTON — Maj. Gen. Paul D. Eaton, a retired Army officer, is familiar with the perks and pitfalls of power, having commanded tens of thousands of troops at Fort Benning, Ga., managed budgets exceeding \$2 billion in Iraq, and overseen layers upon layers of staff members who helped manage both his professional duties and his personal life.

He has experienced the full range of lifestyles that come with military leadership, living at one point in an elegant antebellum mansion, and at another, with eight other officers crowded in a marble bathhouse behind one of Saddam Hussein's old palaces.

When he traveled, he was occasionally able to justify the use of military aircraft, but most times, he said, he flew coach. And today he lives on a pension worth 75 percent of his military salary, with health benefits that cover everything except dental and eye care for himself and his wife.

"We are well compensated, and we live very comfortable lives," General Eaton said, referring to the military's most senior leaders. "But when you look at all the things going on around a general, the nation is getting a very, very high return on its money."

Anecdotal Lead

Not everyone at the Pentagon agrees. Two weeks ago, Defense Secretary Robert M. Gates announced a sweeping effort to improve efficiency that, among other things, takes aim at the military's sacrosanct corps of generals and admirals, ordering his staff to cut at least 50 positions, and making clear that he would be happier if they cut more.

40

August 26, 2010

Generals Wary of Move to Cut Their Ranks

By GINGER THOMPSON and THOM SHANKER

WASHINGTON — Maj. Gen. Paul D. Eaton, a retired Army officer, is familiar with the perks and pitfalls of power, having commanded tens of thousands of troops at Fort Benning, Ga., managed budgets exceeding \$2 billion in Iraq, and overseen layers upon layers of staff members who helped manage both his professional duties and his personal life.

He has experienced the full range of lifestyles that come with military leadership, living at one point in an elegant antebellum mansion, and at another, with eight other officers crowded in a marble bathhouse behind one of Saddam Hussein's old palaces.

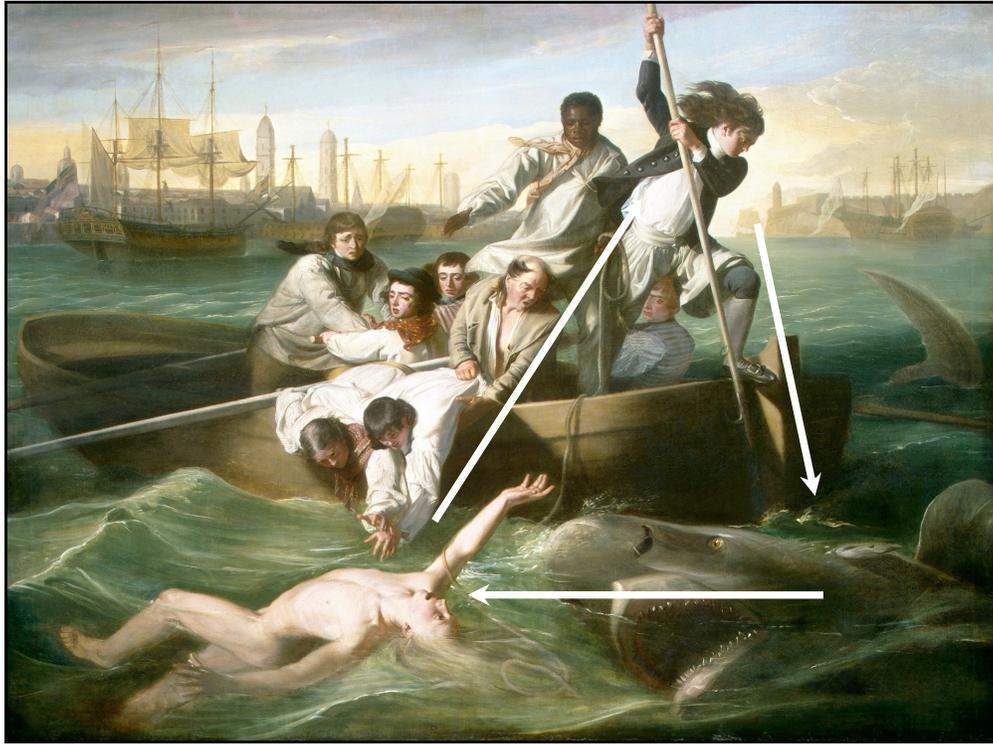
When he traveled, he was occasionally able to justify the use of military aircraft, but most times, he said, he flew coach. And today he lives on a pension worth 75 percent of his military salary, with health benefits that cover everything except dental and eye care for himself and his wife.

"We are well compensated, and we live very comfortable lives," General Eaton said, referring to the military's most senior leaders. "But when you look at all the things going on around a general, the nation is getting a very, very high return on its money."

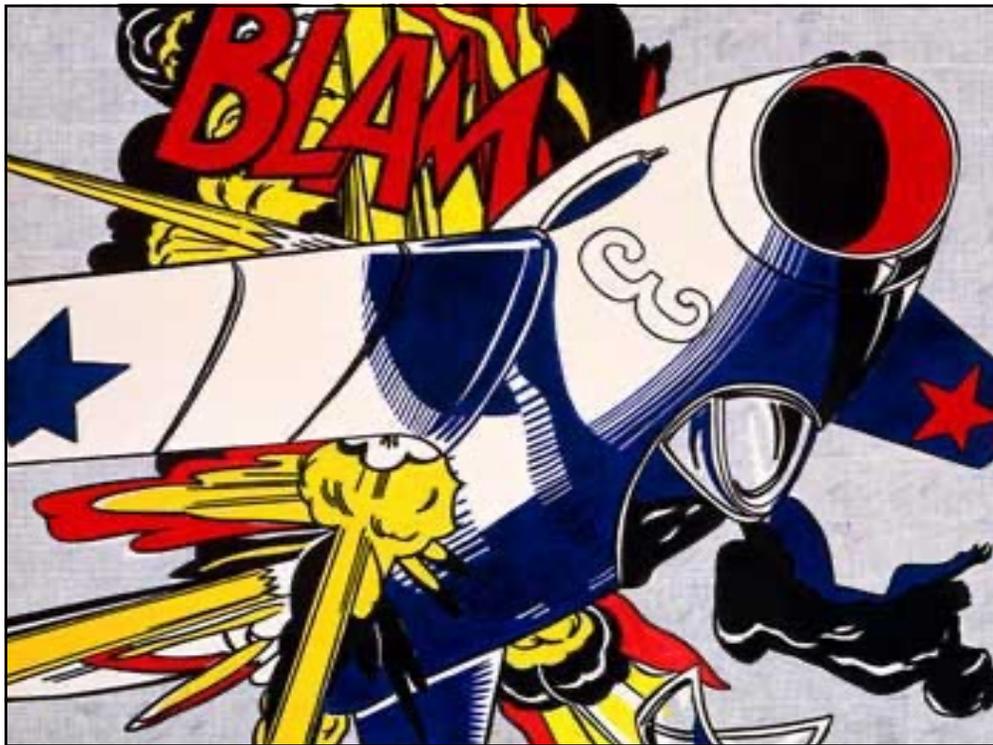
Nut Graph

Not everyone at the Pentagon agrees. Two weeks ago, Defense Secretary Robert M. Gates announced a sweeping effort to improve efficiency that, among other things, takes aim at the military's sacrosanct corps of generals and admirals, ordering his staff to cut at least 50 positions, and making clear that he would be happier if they cut more.

41



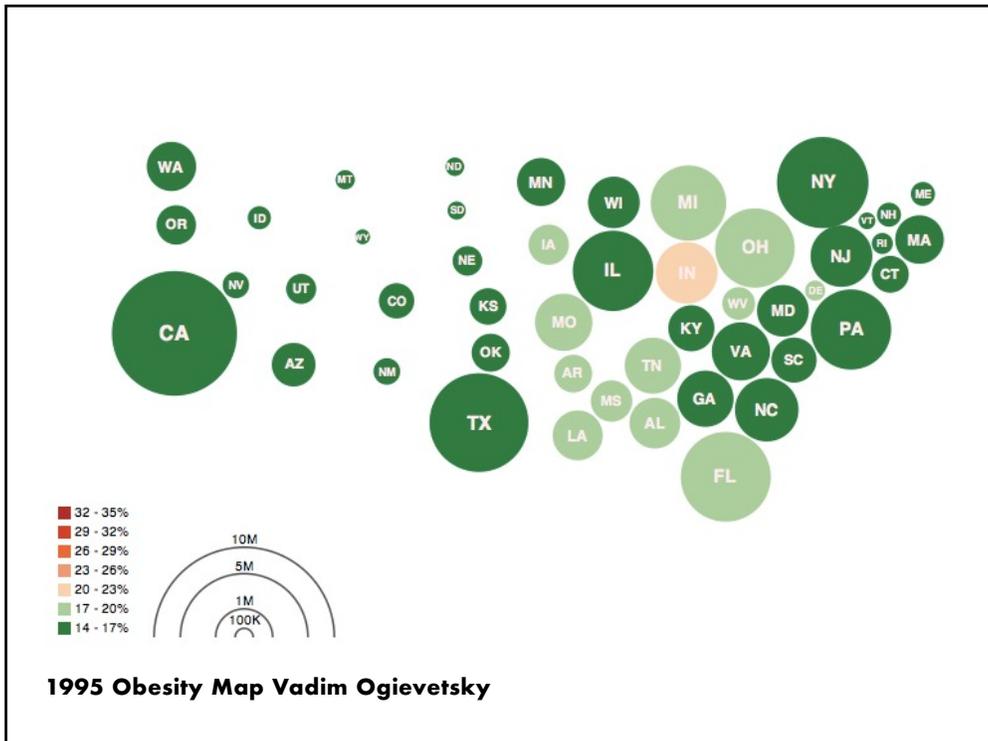
42



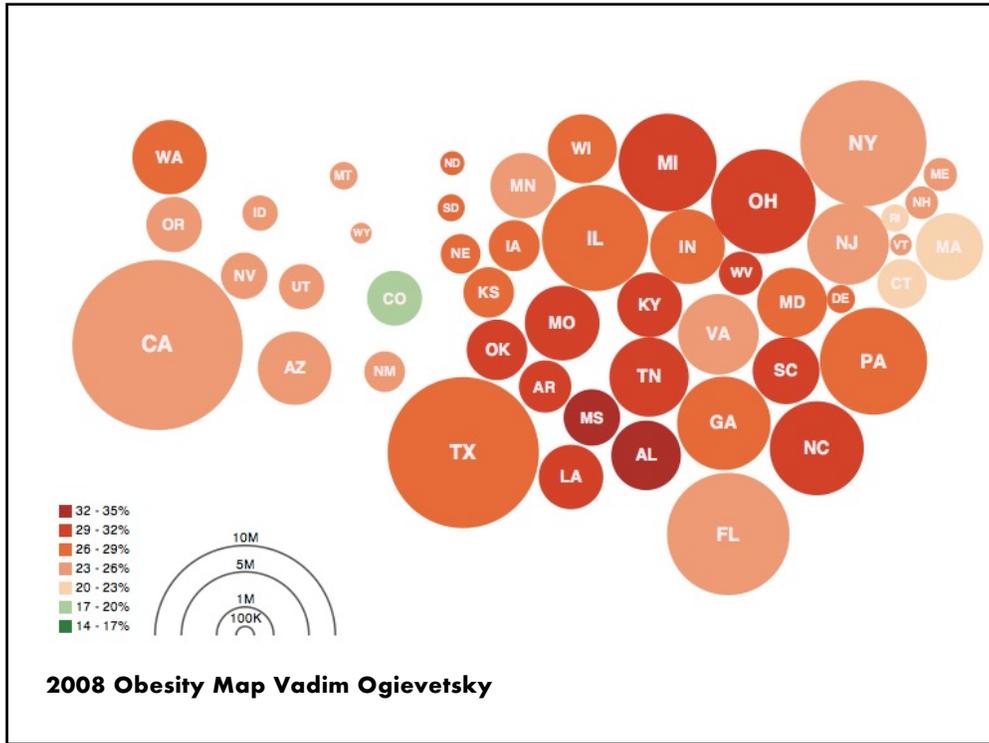
43



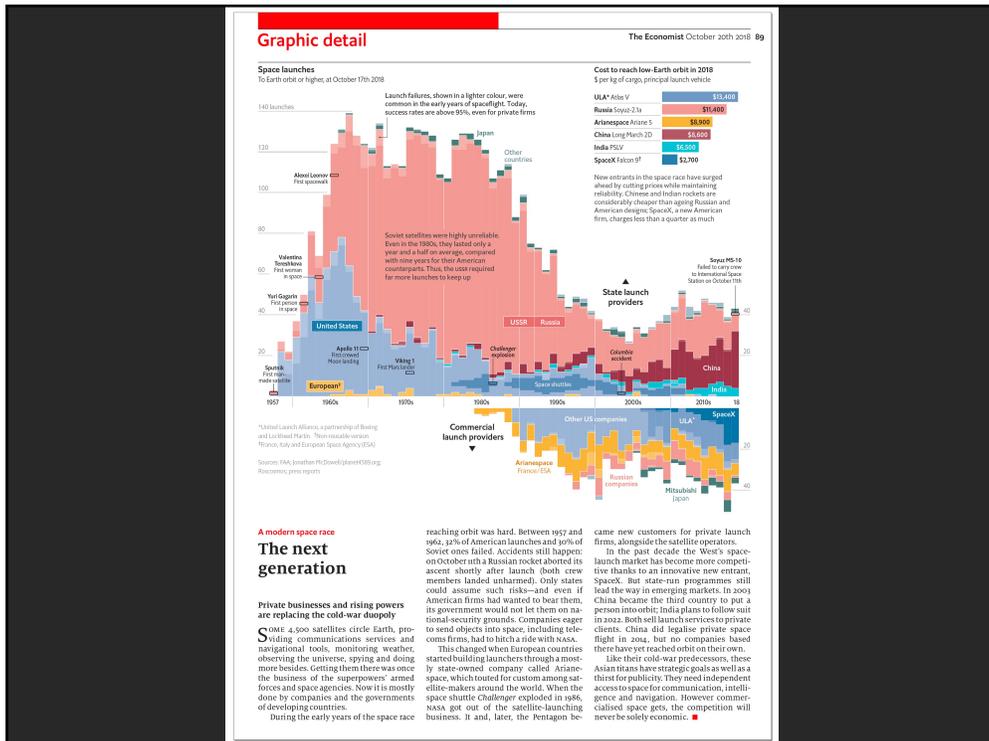
44



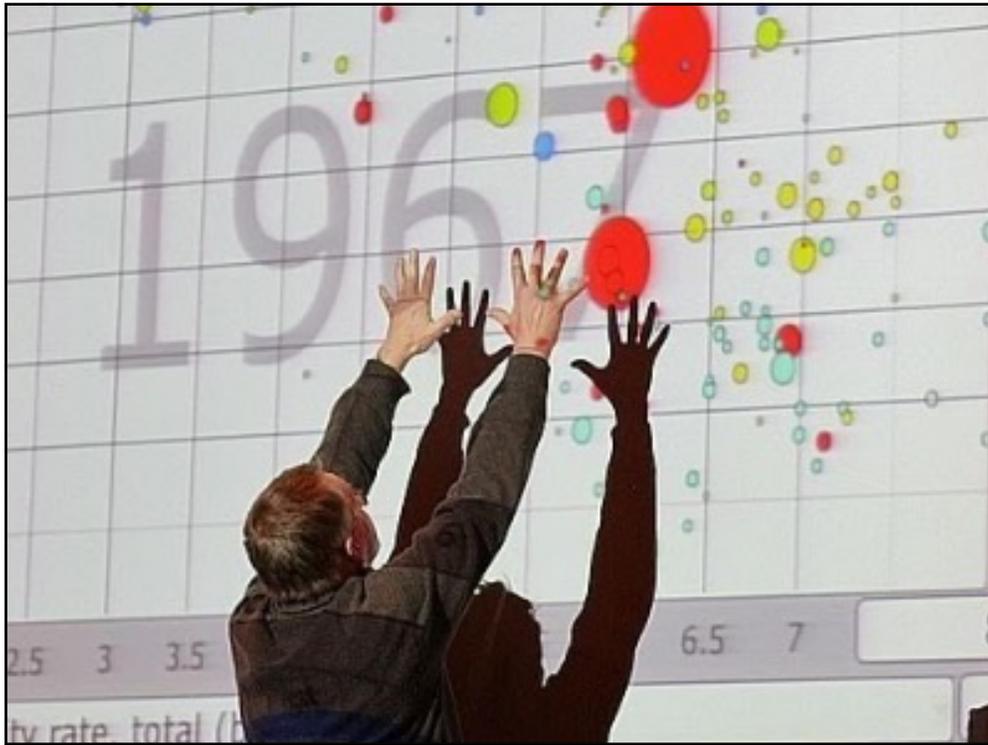
45



46



47



51

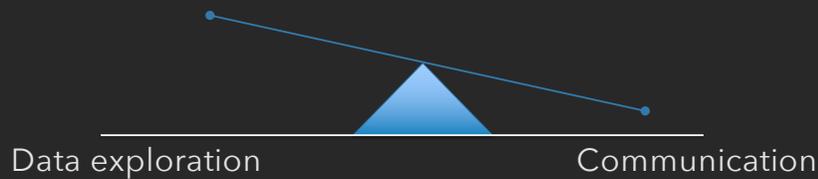
Design Space of Narrative Visualization

52

Value of storytelling [Gershon and Page 2001]

A way of structuring information

- Easier to understand than lists
- Uncertainty, conflict, resolution
- Text and visuals can be complementary

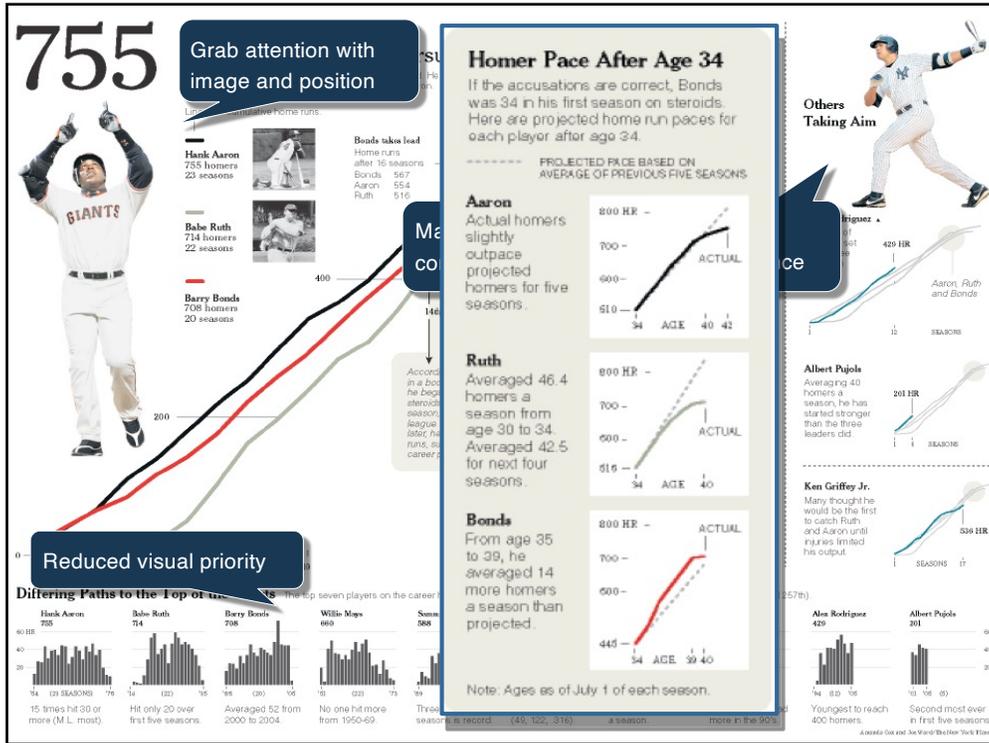


53

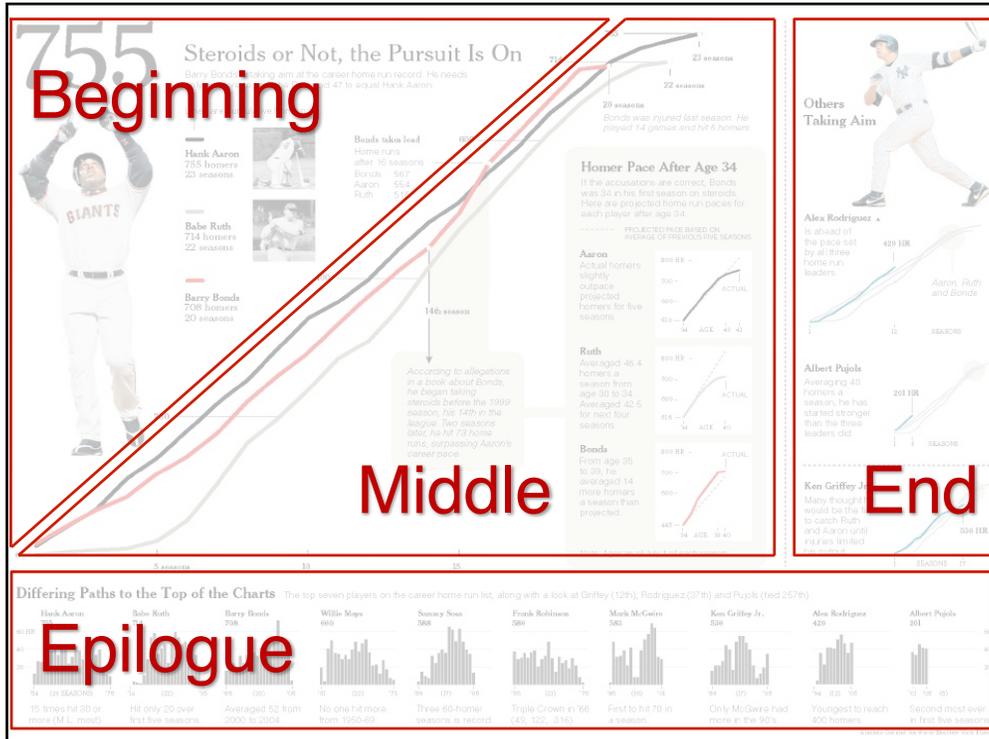
58
CASE STUDIES
70% Journalism
20% Business
10% Research

[Segel & Heer 2010]

54



55



56

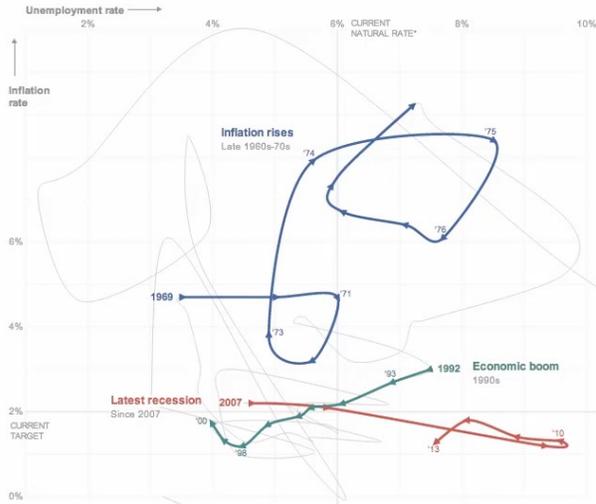
Janet L. Yellen, on the Economy's Twists and Turns

1 2 3 4 5 6 7 NEXT >

Inflation and unemployment

The Federal Reserve is said to have a "dual mandate": keeping inflation in check and the unemployment rate low. These measures, which tend to change cyclically and in concert with each other, are charted for every year since the Great Depression.

In speeches and in meetings, Ms. Yellen, the nominee for the next Fed leader, has commented on the Fed's actions during significant periods, providing a window into her views and priorities.



59

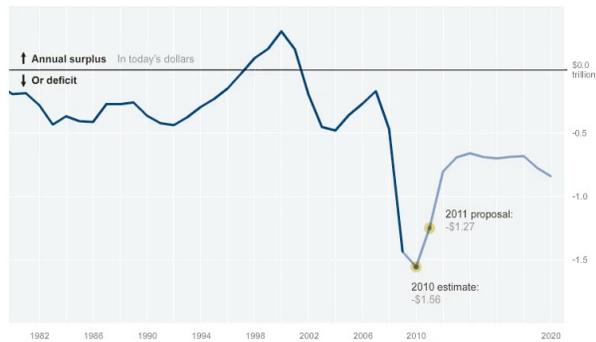
Budget Forecasts, Compared With Reality

Just two years ago, surpluses were predicted by 2012. How accurate have past White House budget forecasts been?

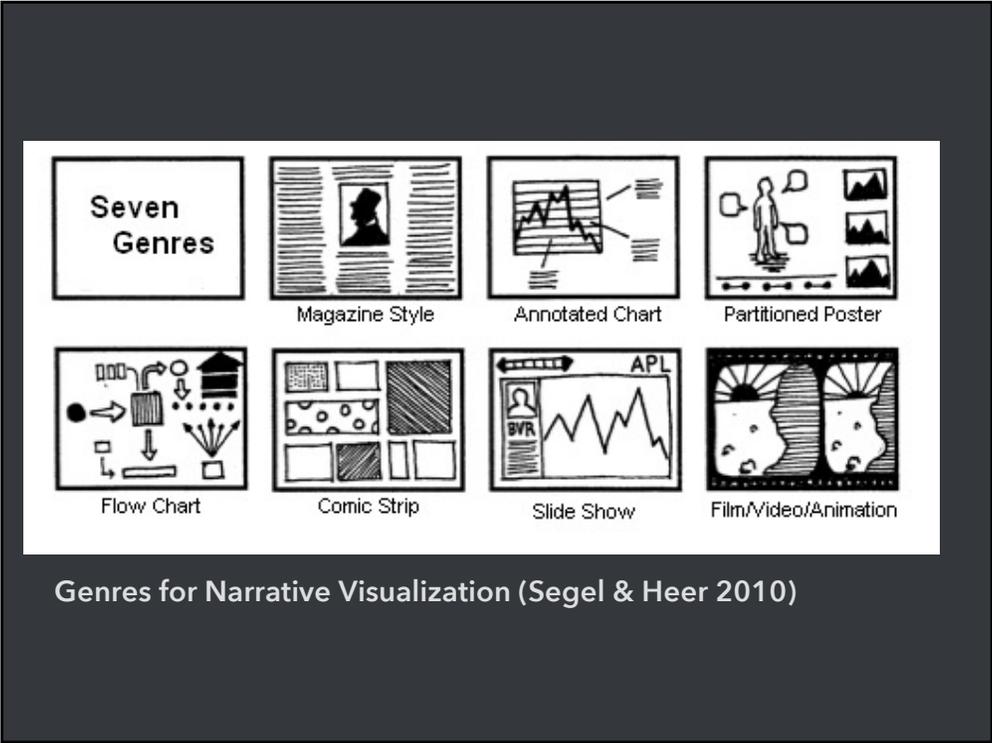
1 2 3 4 5 6 NEXT >

Falling short

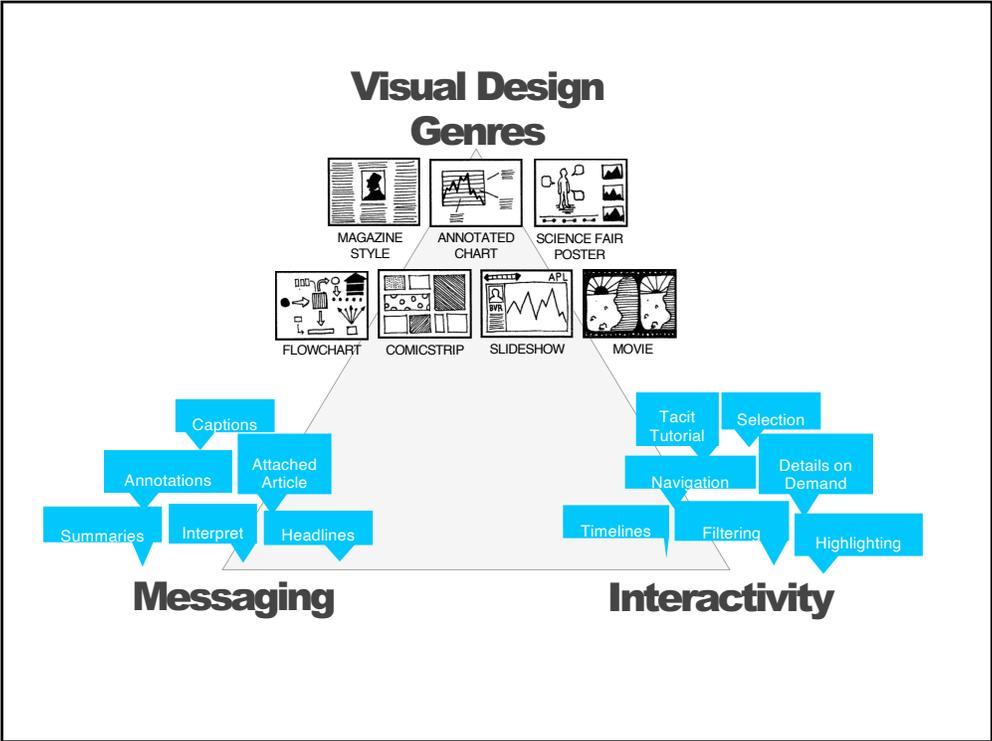
President Obama's budget proposal estimates a deficit of \$1.6 trillion for the current fiscal year and \$1.3 trillion in 2011.



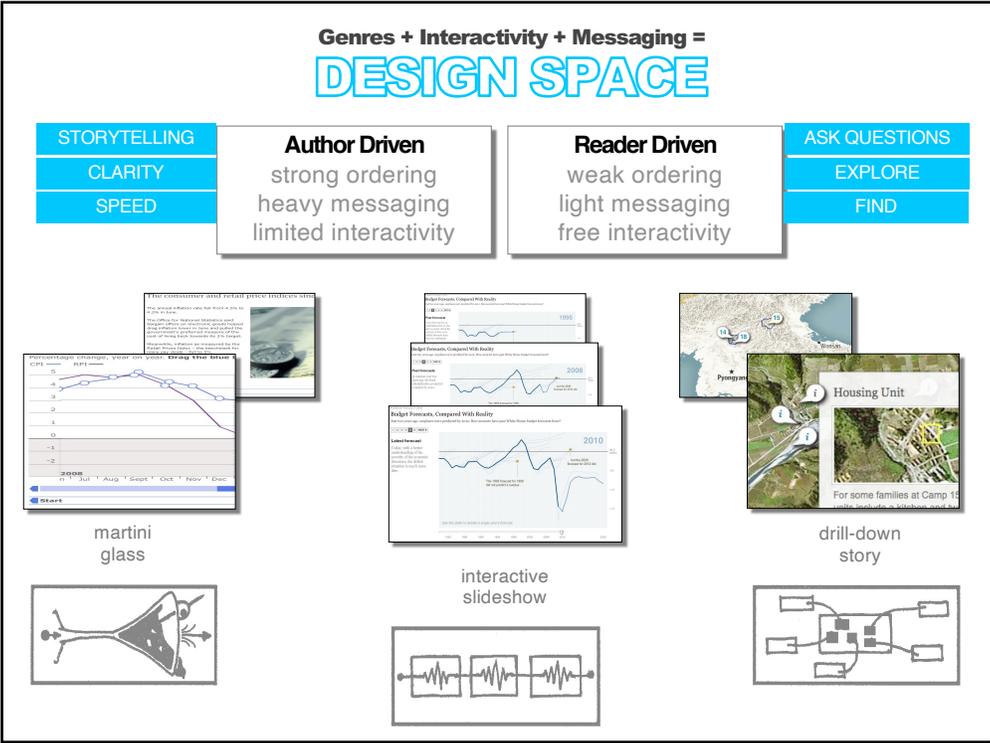
61



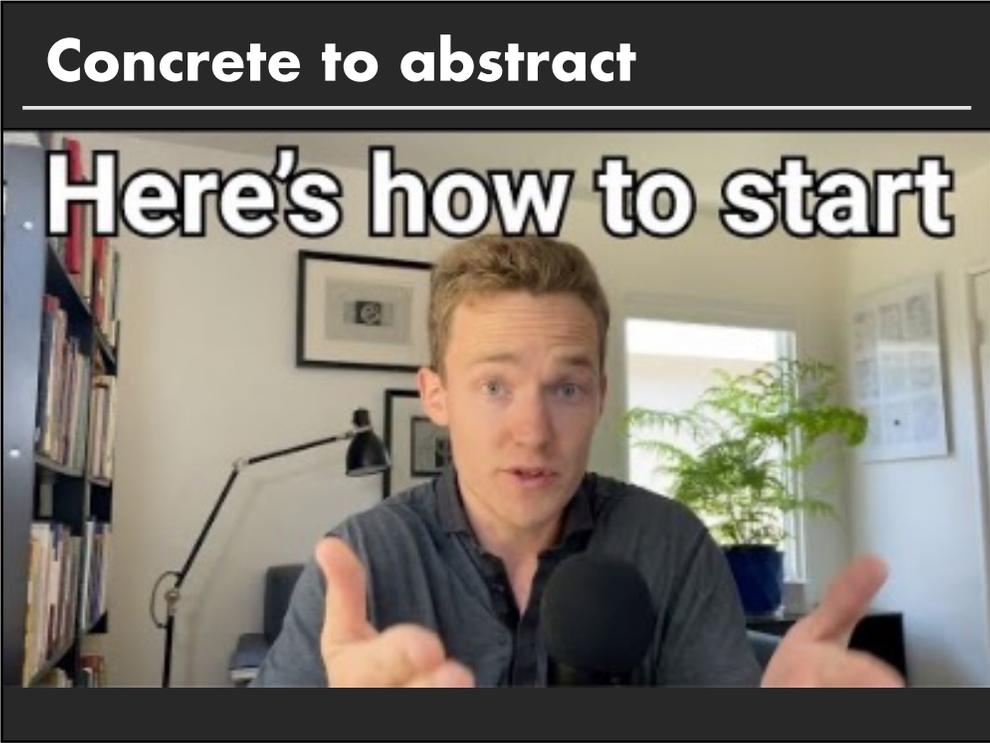
62



64



65



70

NEW YORK

SECTION HOME SEARCH The New York Times Account

SHARE 104

How 2 M.T.A. Decisions Pushed the Subway Into Crisis

By ADAM PEARCE MAY 9, 2018

Source: M.T.A. on-time performance data

By now, New York City commuters are familiar with the wait. We descend from the bitter cold or the stifling heat to find subway platforms teeming with other bodies trying to make it to work on time. Delays ripple through the system, so there's barely room to squeeze into the next train that

71

Interactive Documents

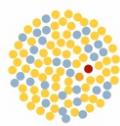
72

Watch how the measles outbreak spreads when kids get vaccinated - and when they don't

● vaccinated
 ● susceptible
 ● vaccinated but susceptible
 ● infected
 ● contact with an infected person



NOT PROTECTED
10.0% vax rate



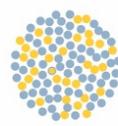
NOT PROTECTED
30.0% vax rate



50.0% vax rate



58.5% vax rate, similar to Okanagan County, WA



68.9% vax rate, similar to Thurston County, WA



74.4% vax rate, similar to Island County, WA



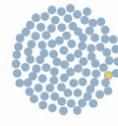
83.8% vax rate, similar to Santa Cruz County, CA



86.0% vax rate, similar to Los Angeles County, CA



90.0% vax rate, similar to Orange County, CA



99.7% vax rate, similar to Gadsden County, FL

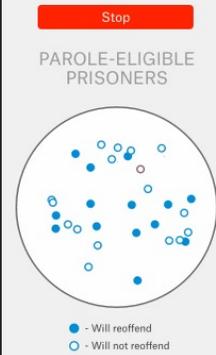
73

Who Should Get Parole?

Even the best risk assessments yield probabilities, not certainties. That means they label as "high risk" some people who won't commit another crime and label as "low risk" some people who will. This simulation lets you sort offenders into risk categories based on the results of an assessment. Think we should rarely lock up anyone who wouldn't reoffend? Set the "low risk" threshold high and the "high risk" threshold even higher. Have little tolerance for recidivism? Try the opposite. In the real world, policymakers have to strike a balance. [Read more »](#)

1

The prisoners in this simulation are up for parole. Some will reoffend if released and some won't. They each take an assessment, which estimates the chance they will reoffend.



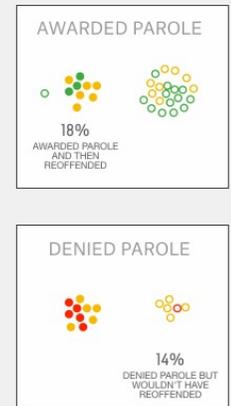
2

Prisoners are placed in one of three categories based on these estimates. Move the slider to change the cutoffs for each category. "Low risk" prisoners will be awarded parole. "High risk" prisoners will be denied.



3

Some people you let out reoffended. Some people you left in prison wouldn't have. Are you OK with the results?



74

← → ↻ https://distill.pub/2017/momentum/ 🔍 ☆ ⓘ 🔌 🌐 📱 🗂 ⋮

Distill ABOUT PRIZE SUBMIT

Why Momentum Really Works

Starting Point Optimum Solution

Step-size $\alpha = 0.0027$ Momentum $\beta = 0.99$ We often think of Momentum as a means of dampening oscillations and speeding up the iterations, leading to faster convergence. But it

75

You Draw It: What Got Better or Worse During Obama's Presidency

By LARRY BUCHANAN, HAEYOUN PARK and ADAM PEARCE JAN. 15, 2017

Draw your guesses on the charts below to see if you're as smart as you think you are.

Under President Obama, the **unemployment rate** ...

4.0% 5.8%

BUSH YEARS OBAMA YEARS

2000 '04 '08 '12 '16

Draw the line for the Obama years.

Show me how I did.

77

Chart Sequences

84