

Visual Explainers

Maneesh Agrawala

CS 448B: Visualization
Fall 2020

with material from Matthew Conlen and Jessica Hullman

1

Last Time: Perception

2

Relative magnitude estimation

Most accurate



Least accurate



Position (common) scale
Position (non-aligned) scale



Length



Slope



Angle



Area



Volume



Color hue-saturation-density

3

Gestalt

4

Principles

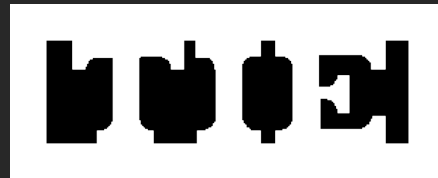
- figure/ground
- proximity
- similarity
- symmetry
- connectedness
- continuity
- closure
- common fate
- transparency

5

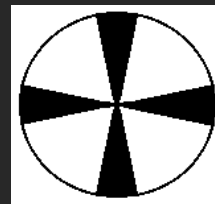
Figure/Ground



Ambiguous



Principle of surroundedness



Principle of relative size

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

6

Figure/Ground



Ambiguous

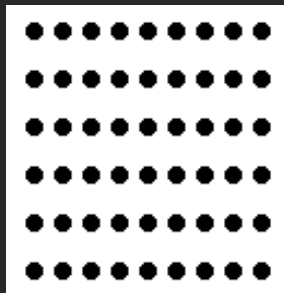
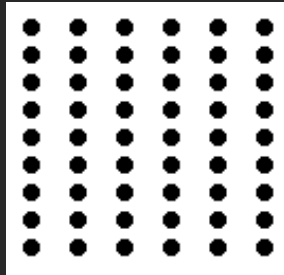


Unambiguous

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

7

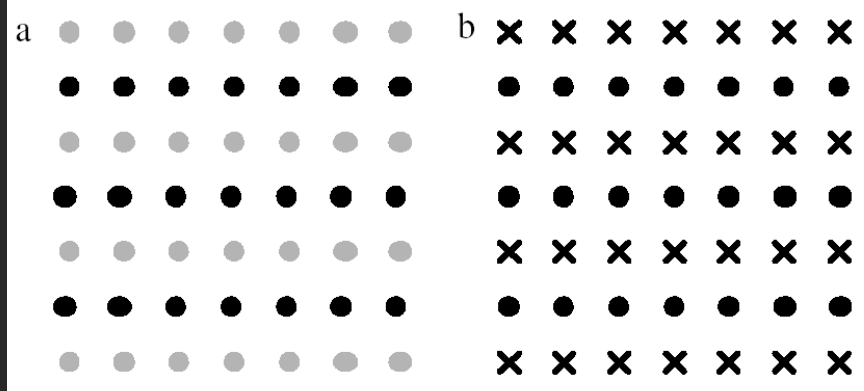
Proximity



[Ware 00]

8

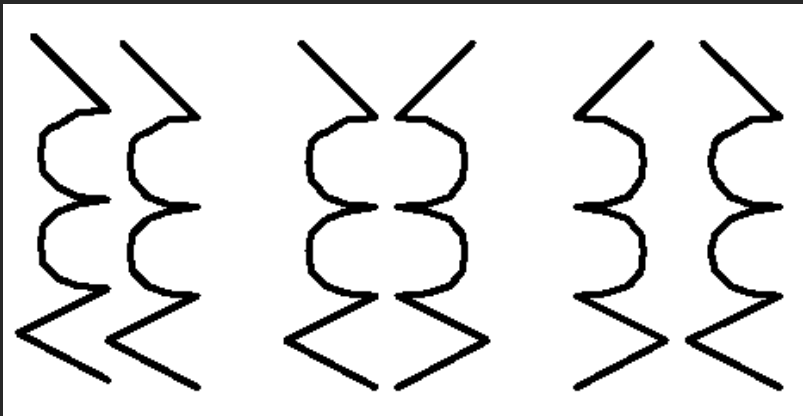
Similarity



Rows dominate due to similarity [from Ware 04]

9

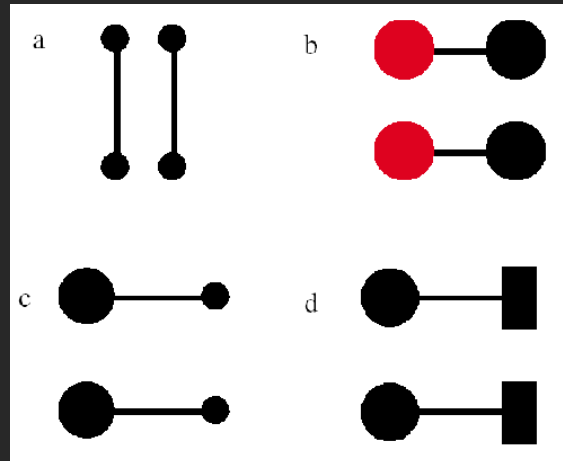
Symmetry



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

10

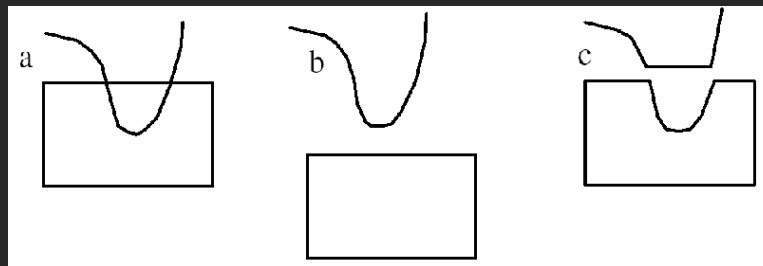
Connectedness



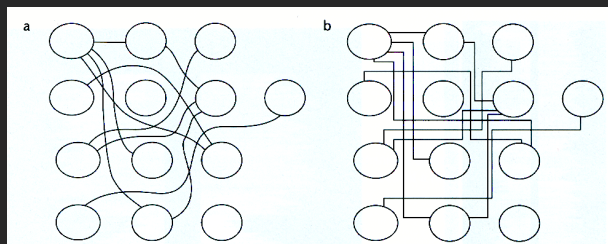
Connectedness overrules proximity, size, color shape [from Ware 04]

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Continuity



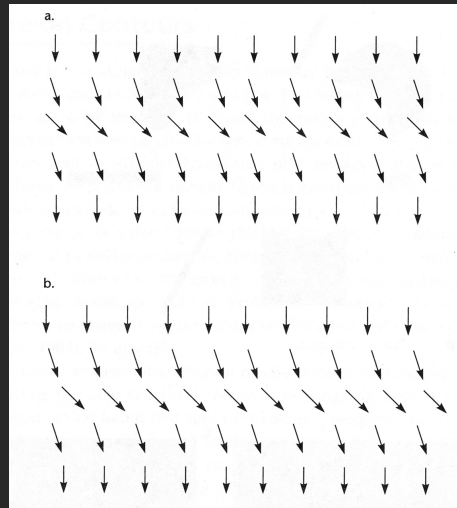
We prefer smooth not abrupt changes [from Ware 04]



Connections are clearer with smooth contours [from Ware 04]

12

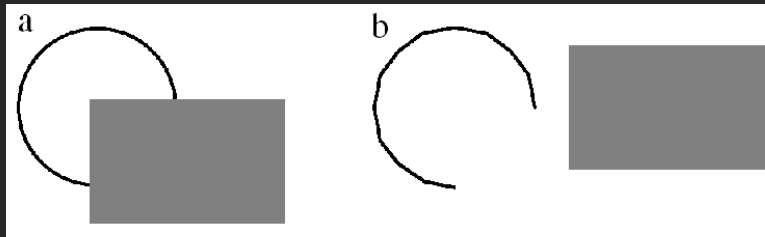
Continuity: Vector fields



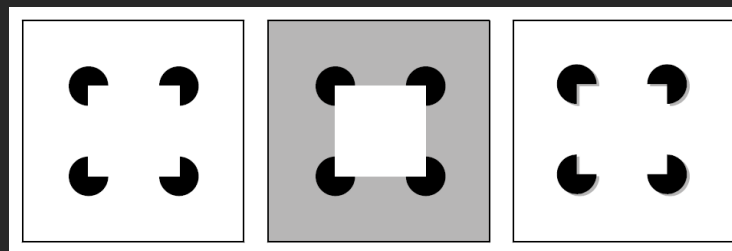
Prefer field that shows smooth continuous contours [from Ware 04]

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Closure



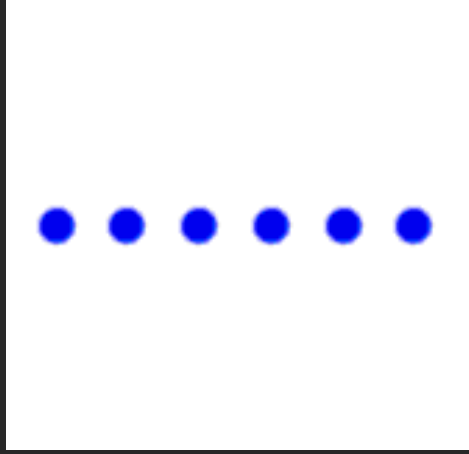
We see a circle behind a rectangle, not a broken circle [from Ware 04]



Illusory contours [from Durand 02]

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Common fate



Dots moving together are grouped

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

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Transparency



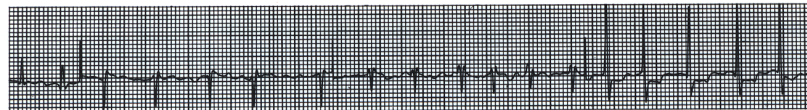
Requires continuity and proper color correspondence [from Ware 04]

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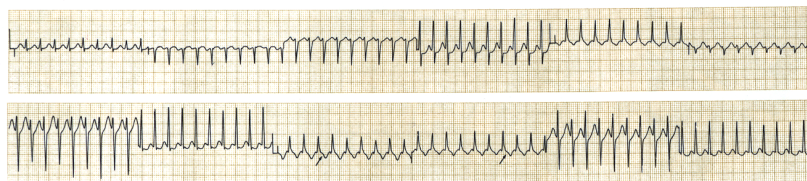
Layering and Small Multiples

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Layering: Gridlines



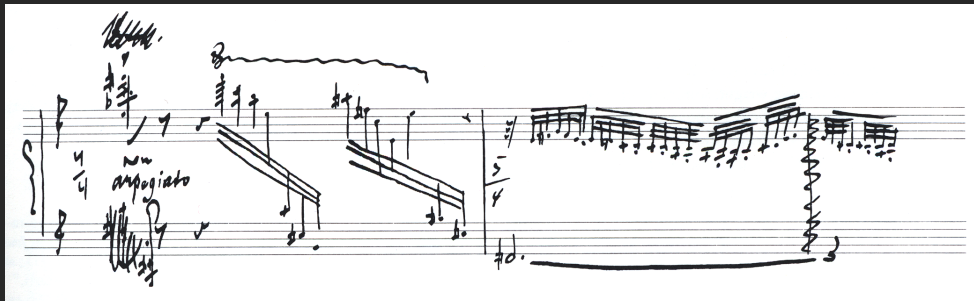
Signal and background compete above, as an electrocardiogram trace-line becomes caught up in a thick grid. Below, the screened-down grid stays behind traces from each of 12 monitoring leads:⁴



Electrocardiogram tracelines [from Tufte 90]

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Layering: Gridlines

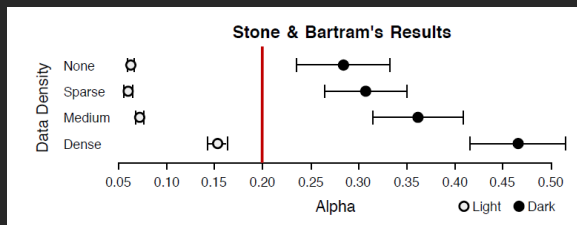


Stravinsky score [from Tufte 90]

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Setting Gridline Contrast

How light can gridlines be and remain visible?
How dark can gridlines be and not distract?

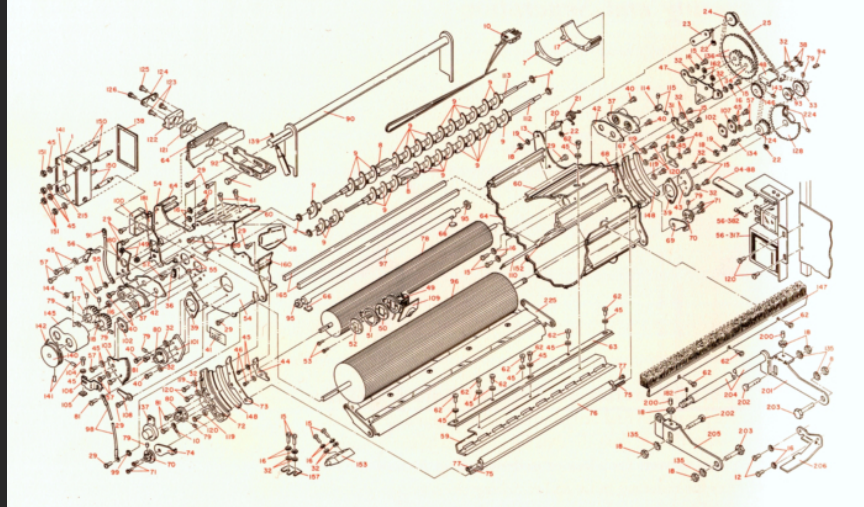


Safe setting:
20% Alpha

[Stone & Bartram 2009]

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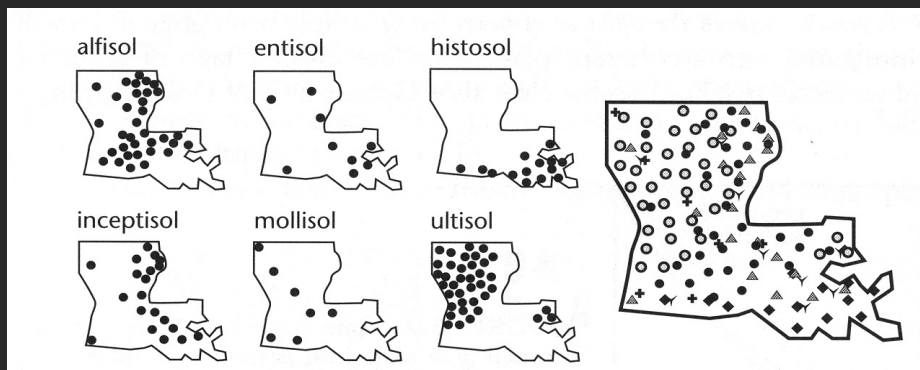
Layering: Color and line width



IBM Series III Copier [from Tufte 90]

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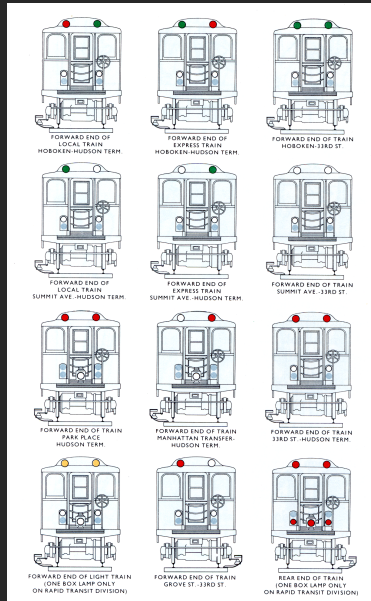
Small multiples



[Figure 2.11, p. 38, MacEachren 95]

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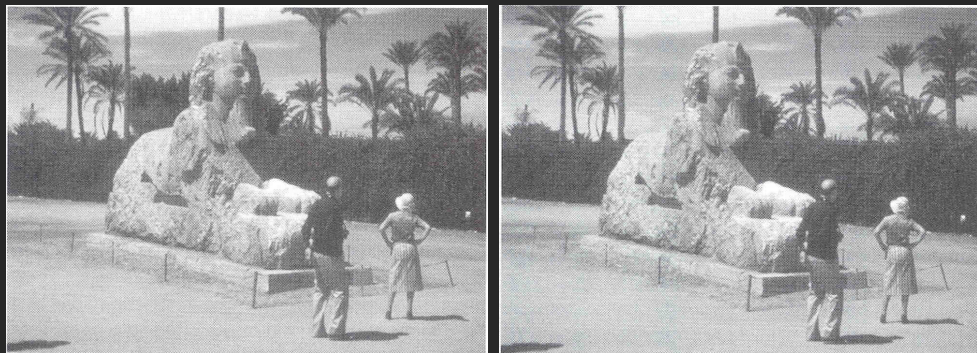
Small multiples



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

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Change blindness



[Example from Palmer 99, originally due to Rock]

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Change detection



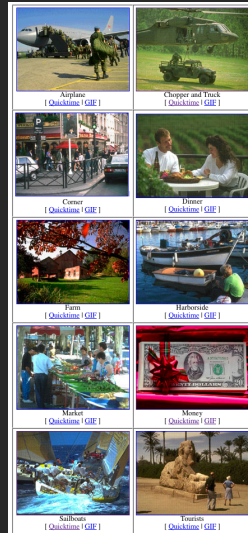
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Change detection



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Rensink's demonstration



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

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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

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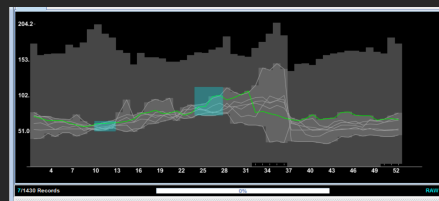
Announcements

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Assignment 3: Dynamic Queries

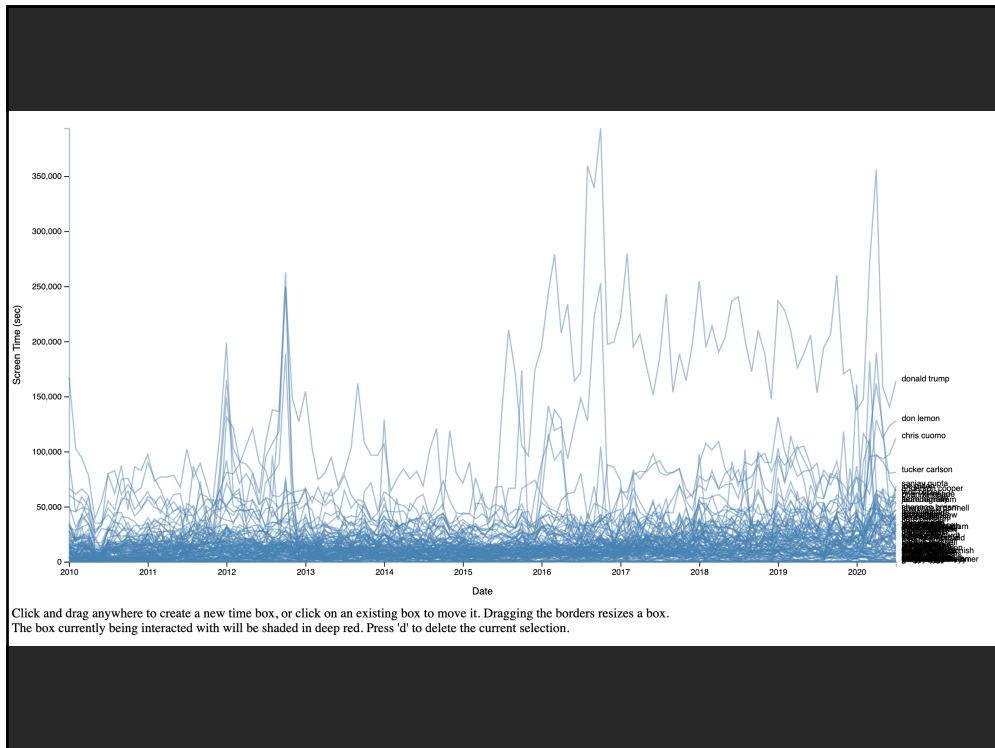
Create a **small** interactive dynamic query application similar to TimeSearcher, but for top 100 personalities on Cable TV News.

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



Can work alone or in pairs
Due before class on **Oct 20, 2020**

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Discussing assignment

Dae Hyun posted notebook on Piazza on creating brushable linecharts

Extra office hours

- Dae Hyun Tu and Th this week 7-8pm

We are happy to discuss your code

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

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Class Schedule Updates

No class Tu Nov 3rd – VOTE!

Guest Lecture Th Nov 12

Jessica Hullman on
Visualizing Uncertainty



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Visual Explainers

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Topics

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

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Storytelling

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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...**

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All media tell stories

PEOPLE TELL STORIES

WORDS TELL STORIES

IMAGES TELL STORIES

COMICS TELL STORIES

MOVIES TELL STORIES

VISUALIZATIONS TELL STORIES

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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

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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.

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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.

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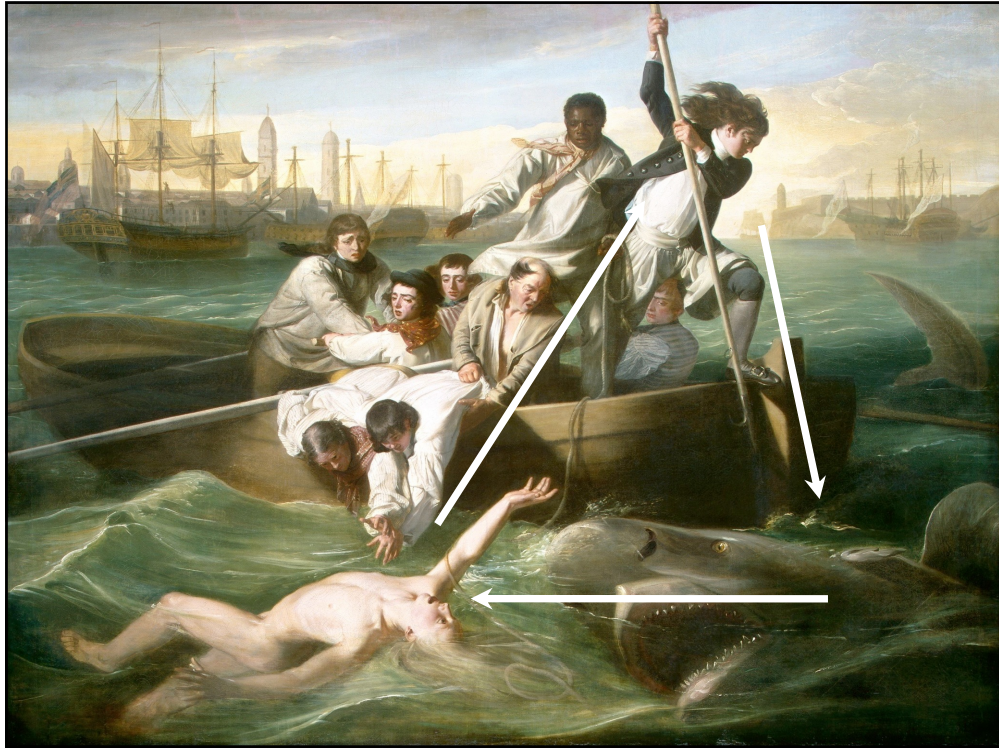
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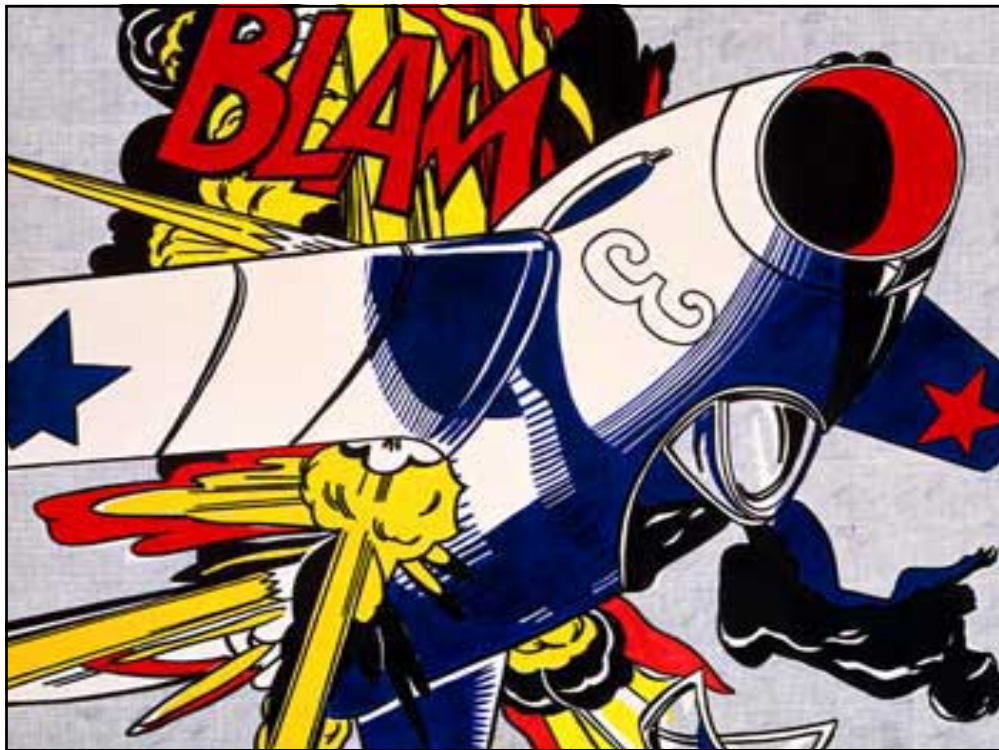
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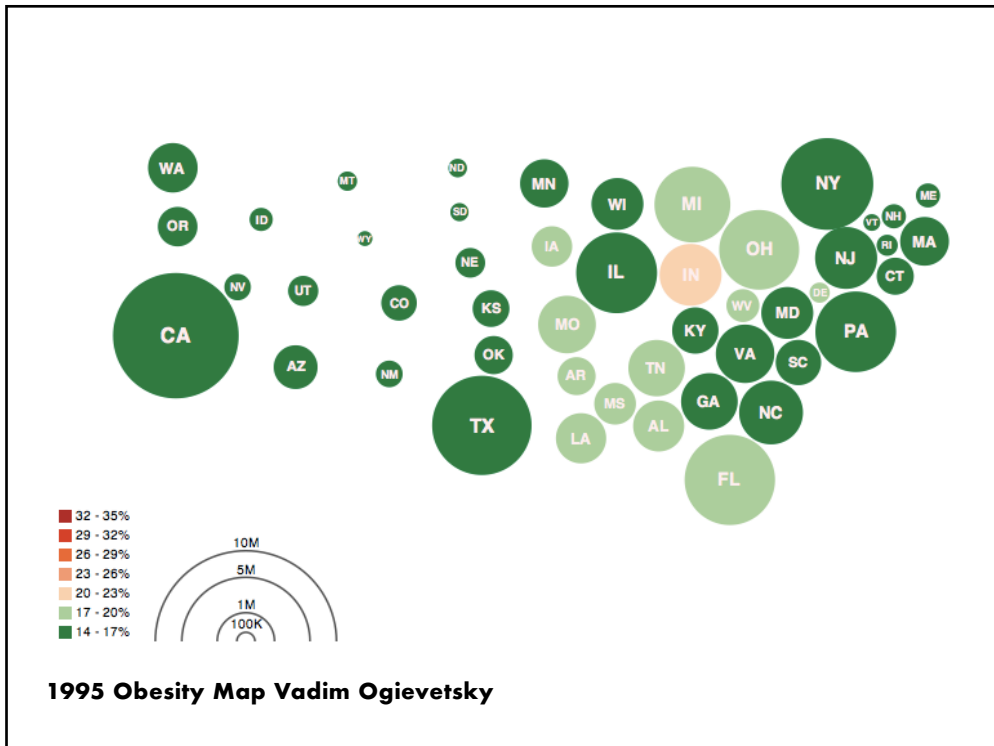
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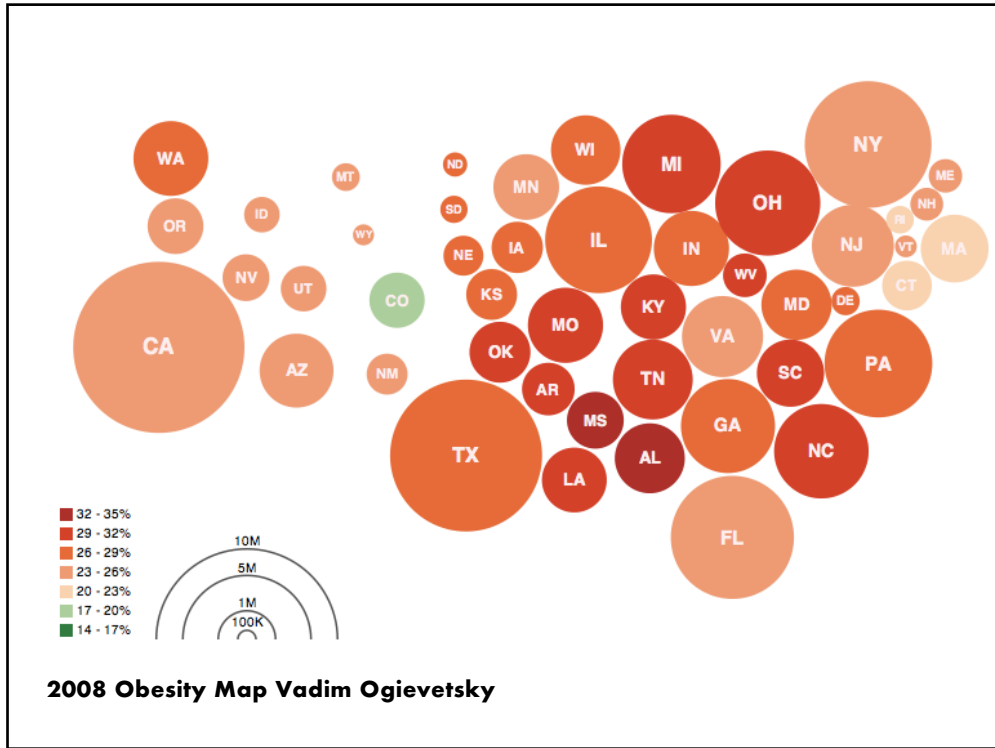
44



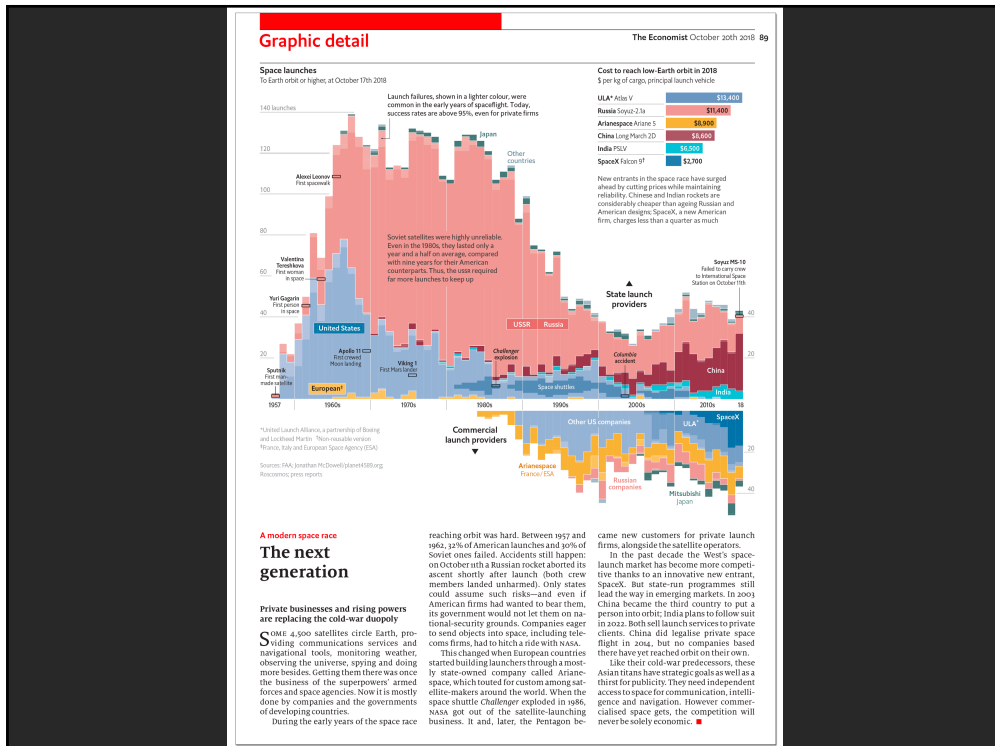
45



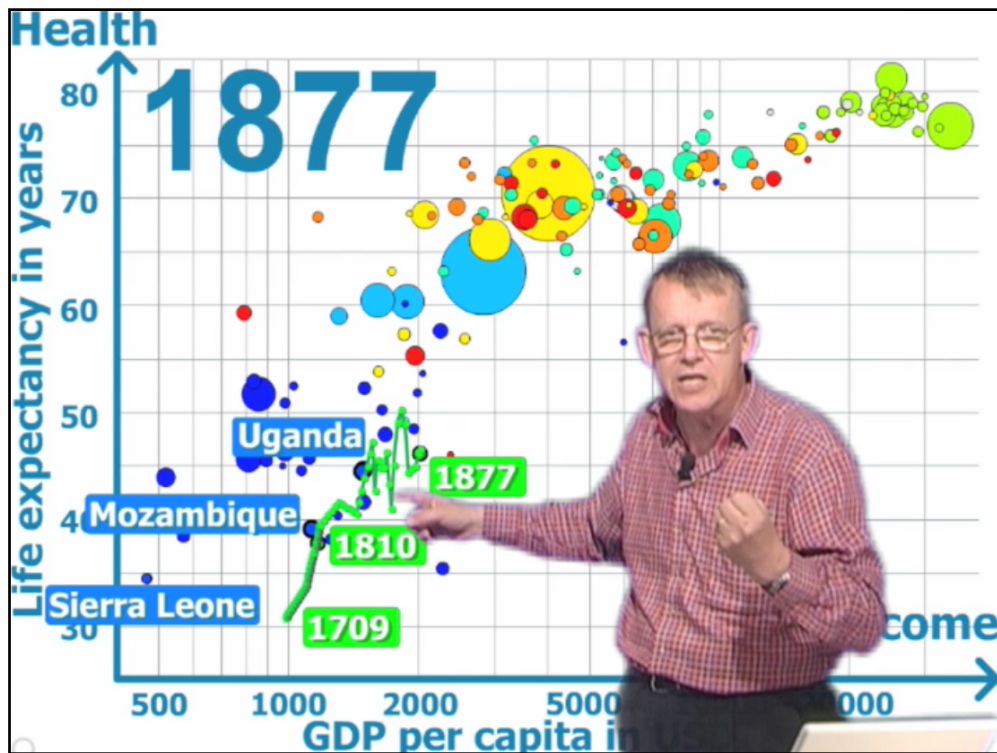
46



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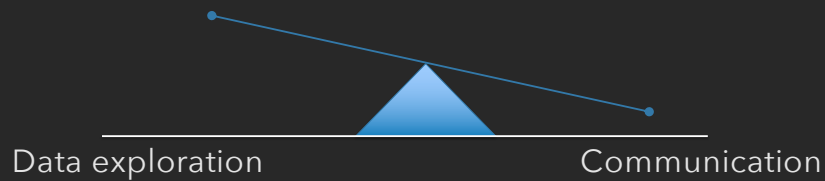
Design Space of Narrative Visualization

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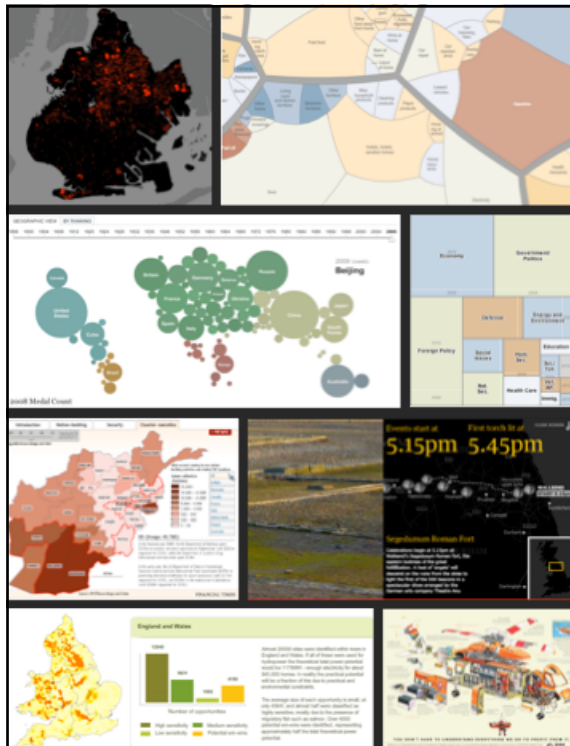
Value of storytelling [Gershon and Page 2001]

A way of structuring information

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



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58 CASE STUDIES

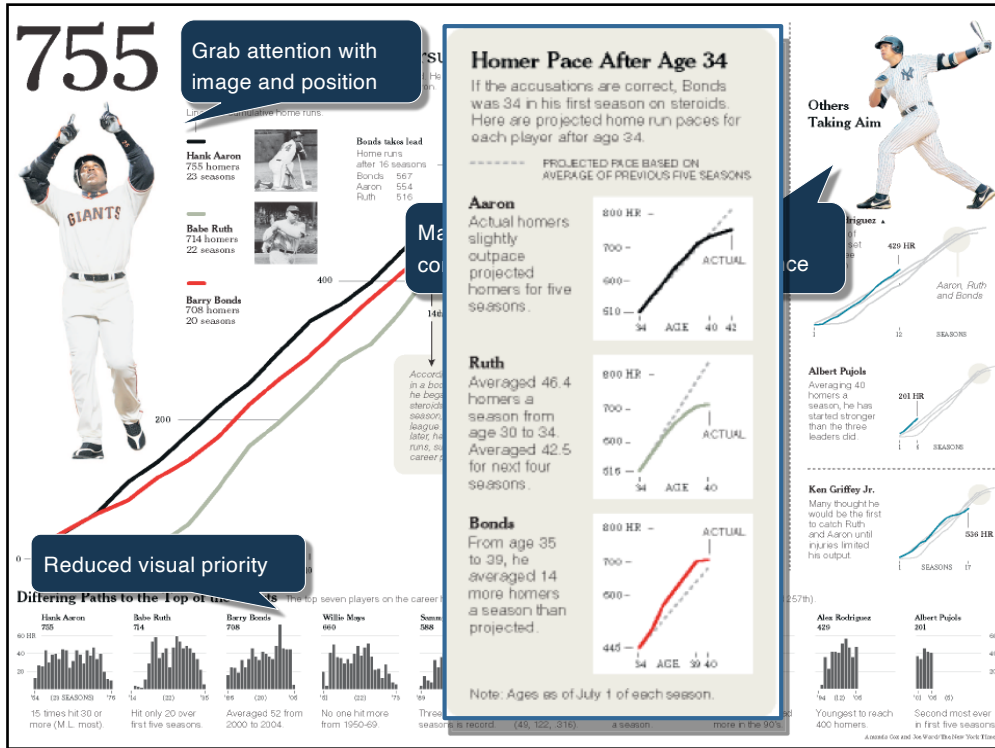
70% Journalism

20% Business

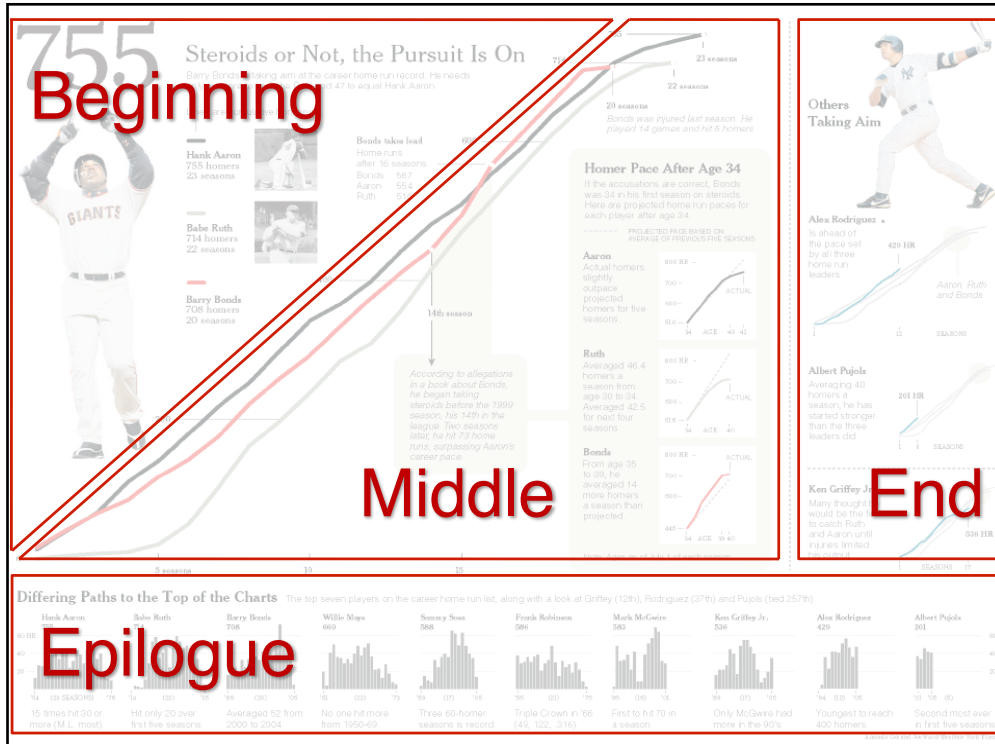
10% Research

[Segel & Heer 2010]

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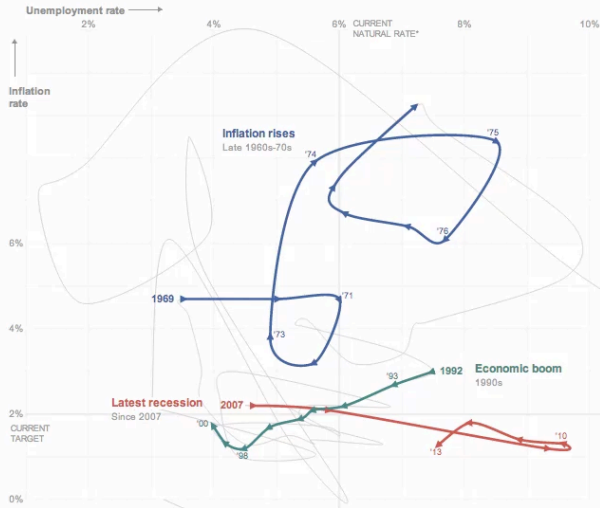
Janet L. Yellen, on the Economy's Twists and Turns

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.



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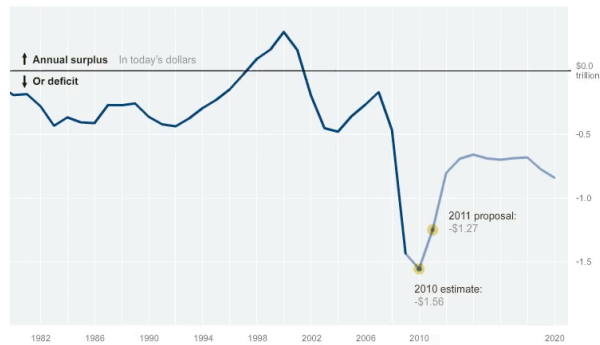
Budget Forecasts, Compared With Reality

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.



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SECTIONS HOME SEARCH The New York Times Account

NEW YORK SHARE 104

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

By ADAM PEARCE MAY 9, 2018

40% of trains delayed

20%

Delayed trains

2012 2015 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

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Seven Genres

Magazine Style

Annotated Chart

Partitioned Poster

Flow Chart

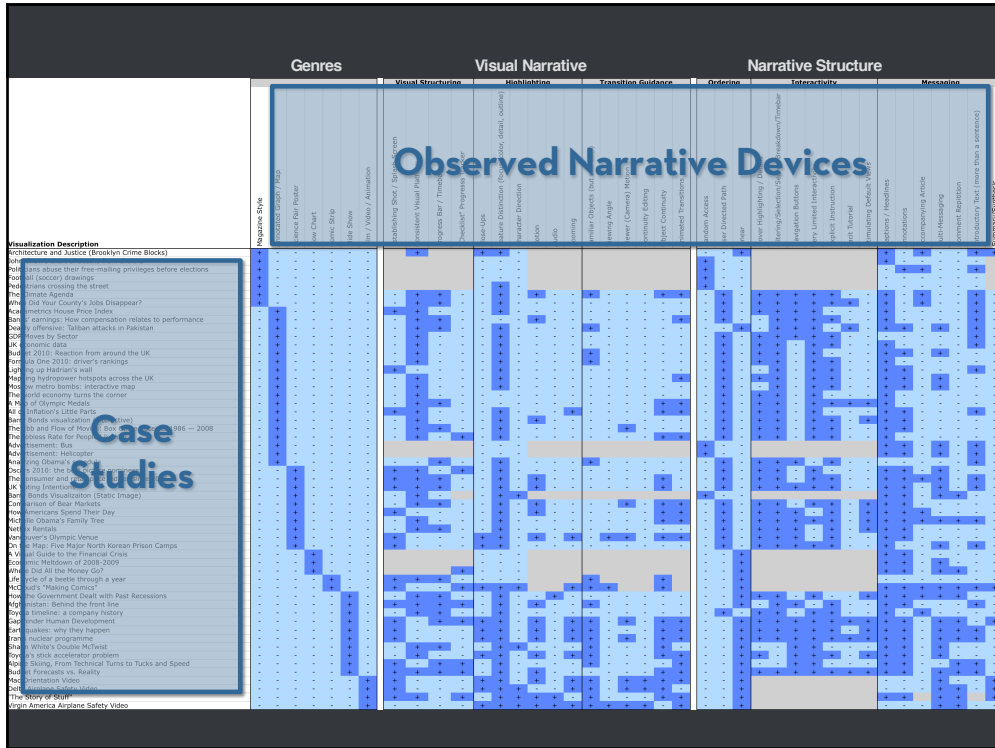
Comic Strip

Slide Show

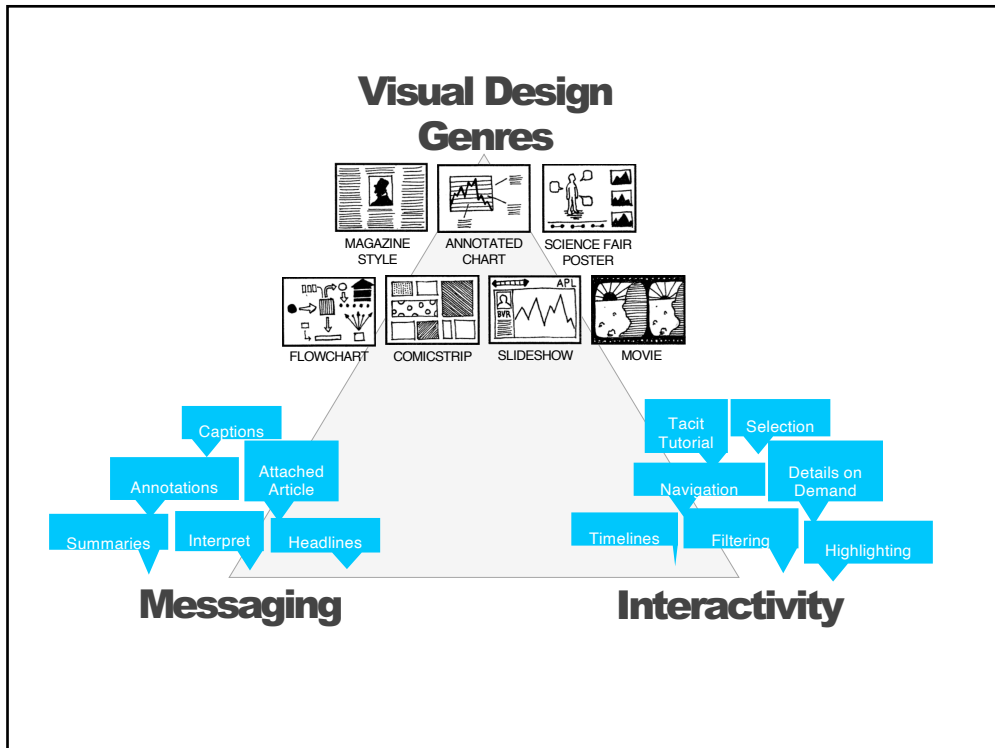
Film/Video/Animation

Genres for Narrative Visualization (Segel & Heer 2010)

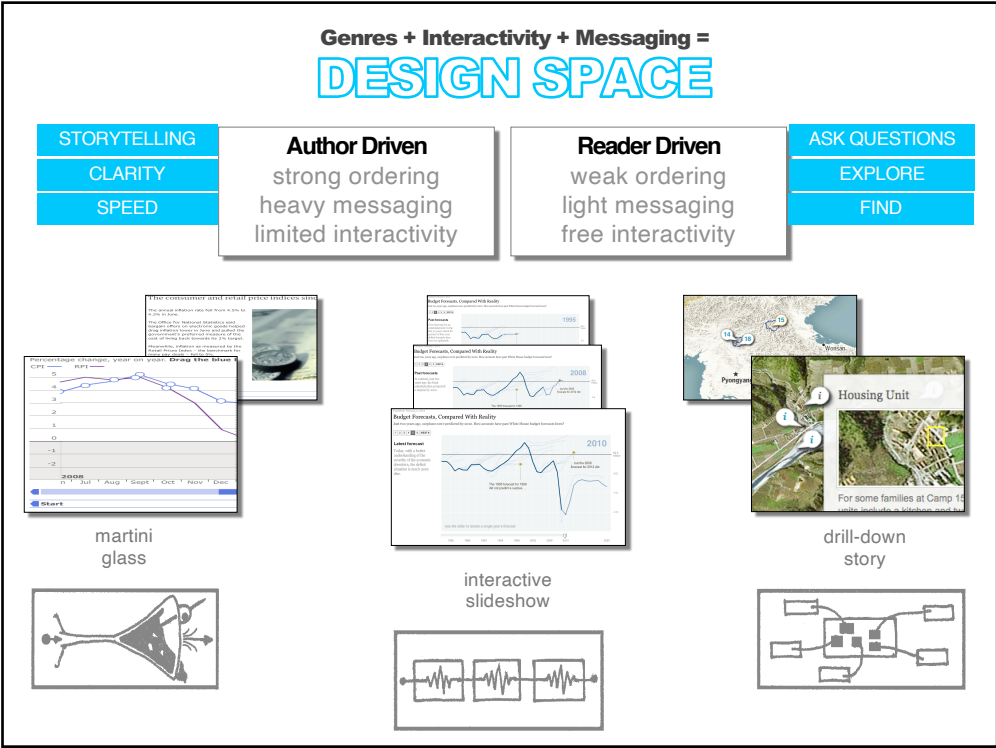
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Narrative theory

Story grammars:
Models of narrative cognition based on systematic studies of what impacts peoples' ability to recall parts of a story

Reader mentally indexes events by time, space, protagonist, causality, intention [Zwaan 1995]

SUMMARY OF REWRITE RULES FOR A SIMPLE STORY GRAMMAR*

FABLE → STORY AND MORAL

STORY → SETTING AND EVENT STRUCTURE

SETTING → { STATE* (AND EVENT*)
EVENT* }

STATE* → STATE ((AND STATE)*)

EVENT* → EVENT (({ AND
THEN } EVENT*) ((AND STATE)*
CAUSE))

EVENT STRUCTURE → EPISODE ((THEN EPISODE)*)

EPISODE → BEGINNING CAUSE DEVELOPMENT CAUSE ENDING

BEGINNING → { EVENT*
EPISODE }

DEVELOPMENT → { SIMPLE REACTION CAUSE ACTION
COMPLEX REACTION CAUSE GOAL PATH }

SIMPLE REACTION → INTERNAL EVENT ((CAUSE INTERNAL EVENT)*)

ACTION → EVENT

COMPLEX REACTION → SIMPLE REACTION CAUSE GOAL

GOAL → INTERNAL STATE

GOAL PATH → { ATTEMPT CAUSE OUTCOME
GOAL PATH (CAUSE GOAL PATH)* }

ATTEMPT → EVENT*

OUTCOME → { EVENT*
EPISODE }

ENDING → { EVENT* (AND EMPHASIS)
EMPHASIS }

EMPHASIS → STATE

Remembrance of Things Parsed [Mandler and Johnson 1977]

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Narrative theory applied

European Alliances before World War I (1836-1914)

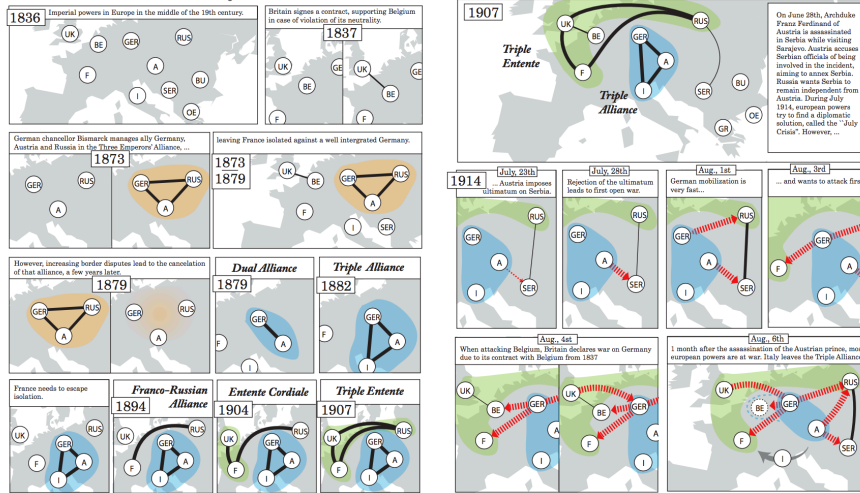


Figure 3. Graph comic example illustrating historical events preceding WWI, targeted to a general audience.

Graph Comics [Bach et al. 2016]

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Narrative theory applied

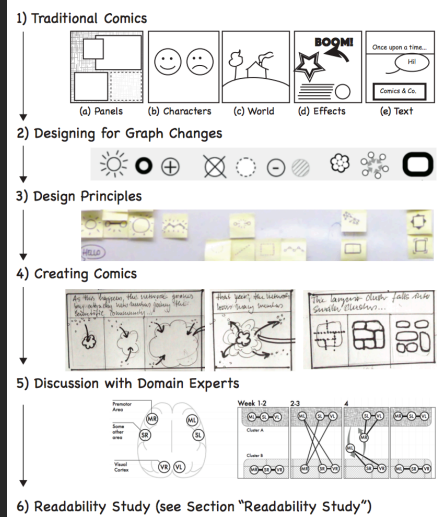
C1. Element identity—Characters in traditional comics are recognizable via their distinct visual features. In graph visualization, nodes and edges are usually represented by circles, sometimes using labels for identifications. Variations in shape and color reflect attributes in the data.

C2. Depicting change—In comics, readers can infer changes even if not shown explicitly. For example, a baby being shown implies it has been born. In graphs, a (new) node being shown does not mean it was not there before.

C3. Order of events—Many changes exhibit a natural order (e.g. humans grow old, objects fall down, day turns into night). Changes in graphs do not have a natural order nor duration; a cluster can grow or shrink, divide or merge.

C4. Spatial context—In comics, the spatial context of a scene is usually indicated by the panel background: the same background means the same place and often the same scene. Switching spatial context from one cluster to another may not be recognized by a reader (both consists of nodes and links).

C5. Number of elements—Comics usually show a small set of characters in every panel. Changes in graphs, may involve many more elements than it is possible to show in a panel.



Graph Comics [Bach et al. 2016]

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