09: **Graphics and visualizations**

March 23, 2012

Announcements

- …

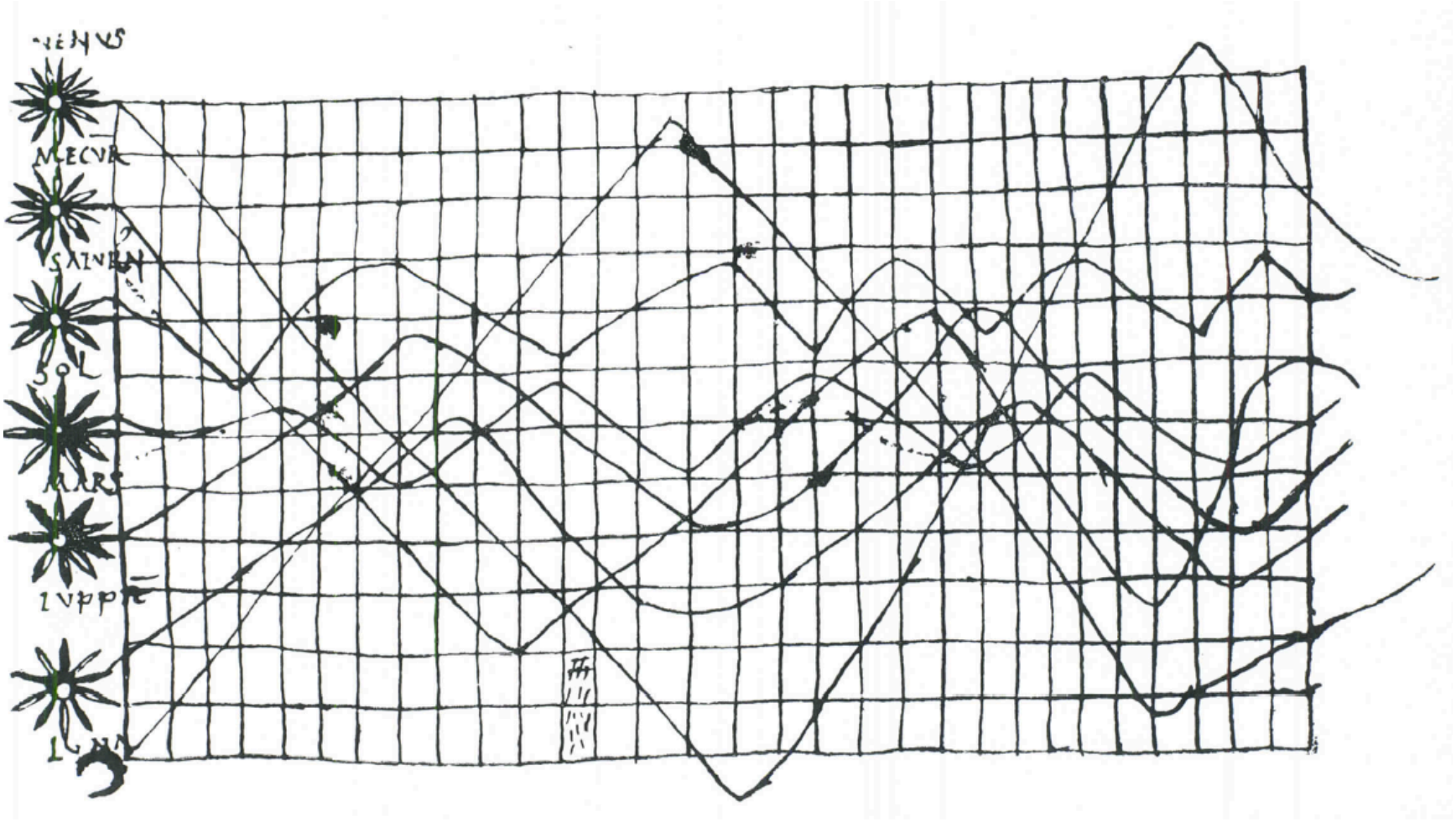
Goals for today

- Discuss how visual information is organized to provide:
  - Maximum information content
  - Minimum work for the reader
- Talk about how to make good figures:
  - Discuss important elements (color, alignment, grouping, text, etc.)
  - Study examples in the context of publications, proposals, and presentation slides (more next week)

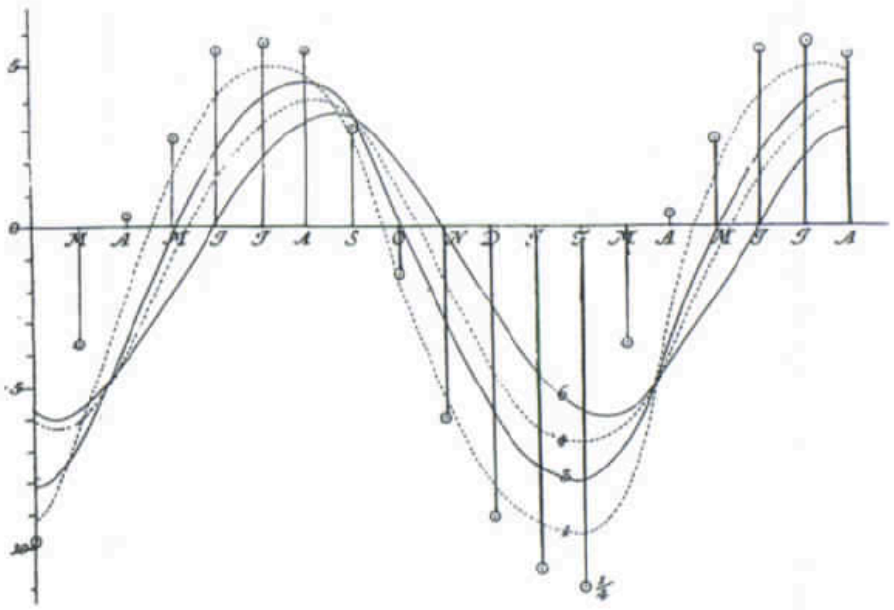
→ Not so many rules, but lots of guidelines

- Have some time for peer-review of draft proposal aims

The first plot ever?



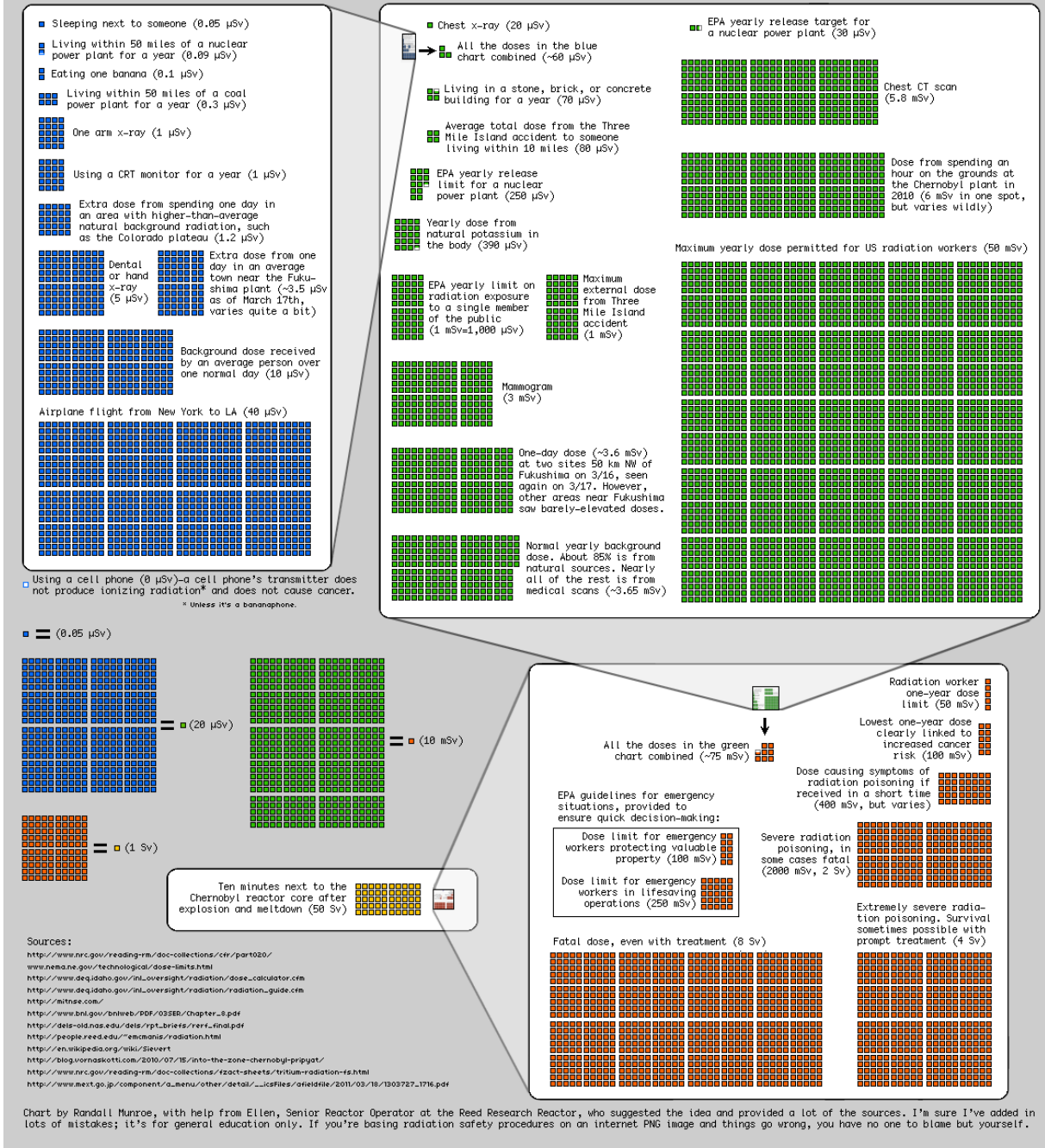
Tufte, The Visual Display of Quantitative Information.



J. H. Lambert, *Pyrometrie* (Berlin, 1779).

Tufte, The Visual Display of Quantitative Information.

An informative visual



A figure should

- Make only one point
  → As a distinct part of the whole story

- Be self-explanatory and easy to read
  → We can skim the paper/proposal by looking at the figures

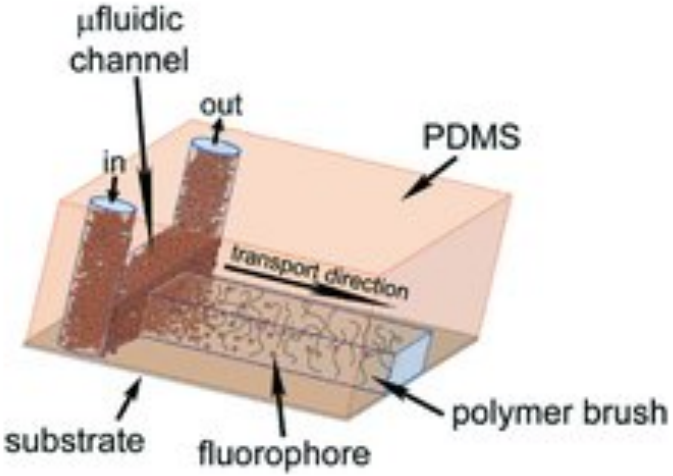
- Use "perceptual tasks that rank high in efficiency and accuracy"

- Use the chosen visual elements efficiently

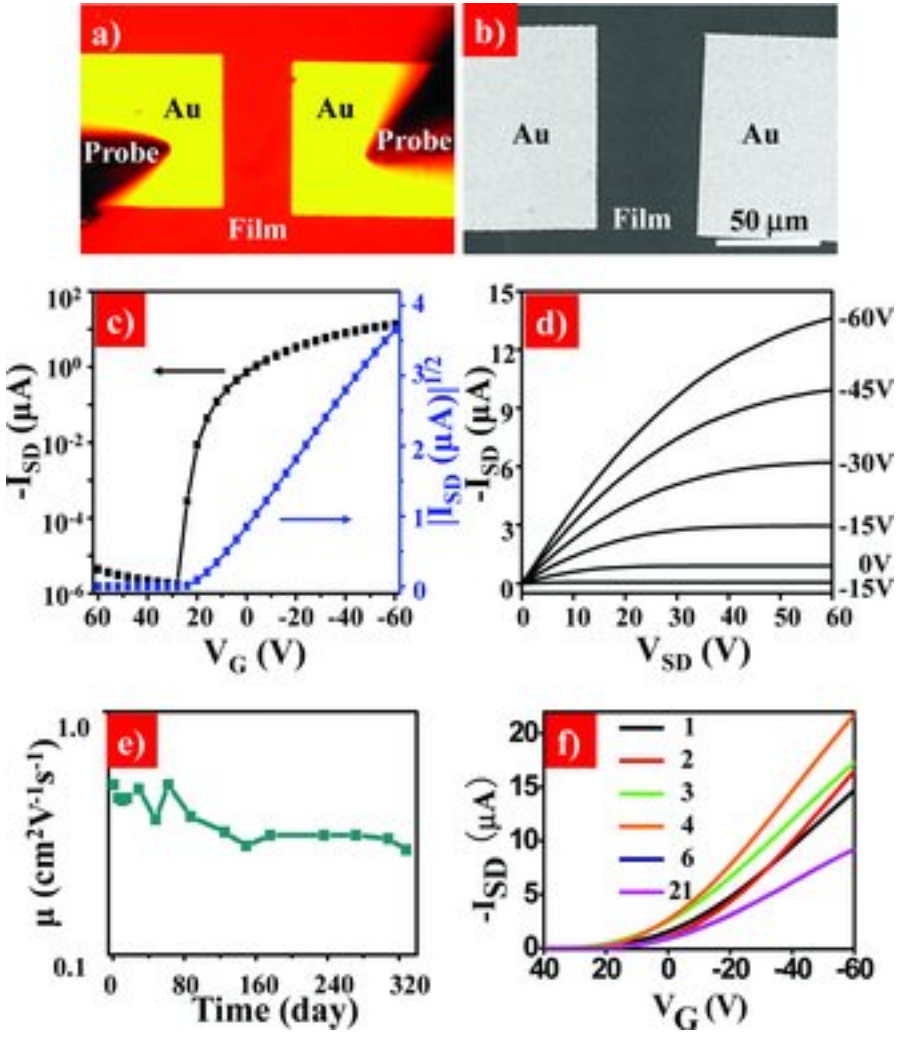
- Be suitable for use on a presentation slide
  → Think about how you would layer the information as you talk

Not-so-good figures

Keywords:
surface modification; polymeric materials; microcon



Patterned polymer brushes are shown to direct the rapidly across the patterned regions, but not on the covers the patterns and bare regions and serves to locations on the substrate is demonstrated.



Improvement

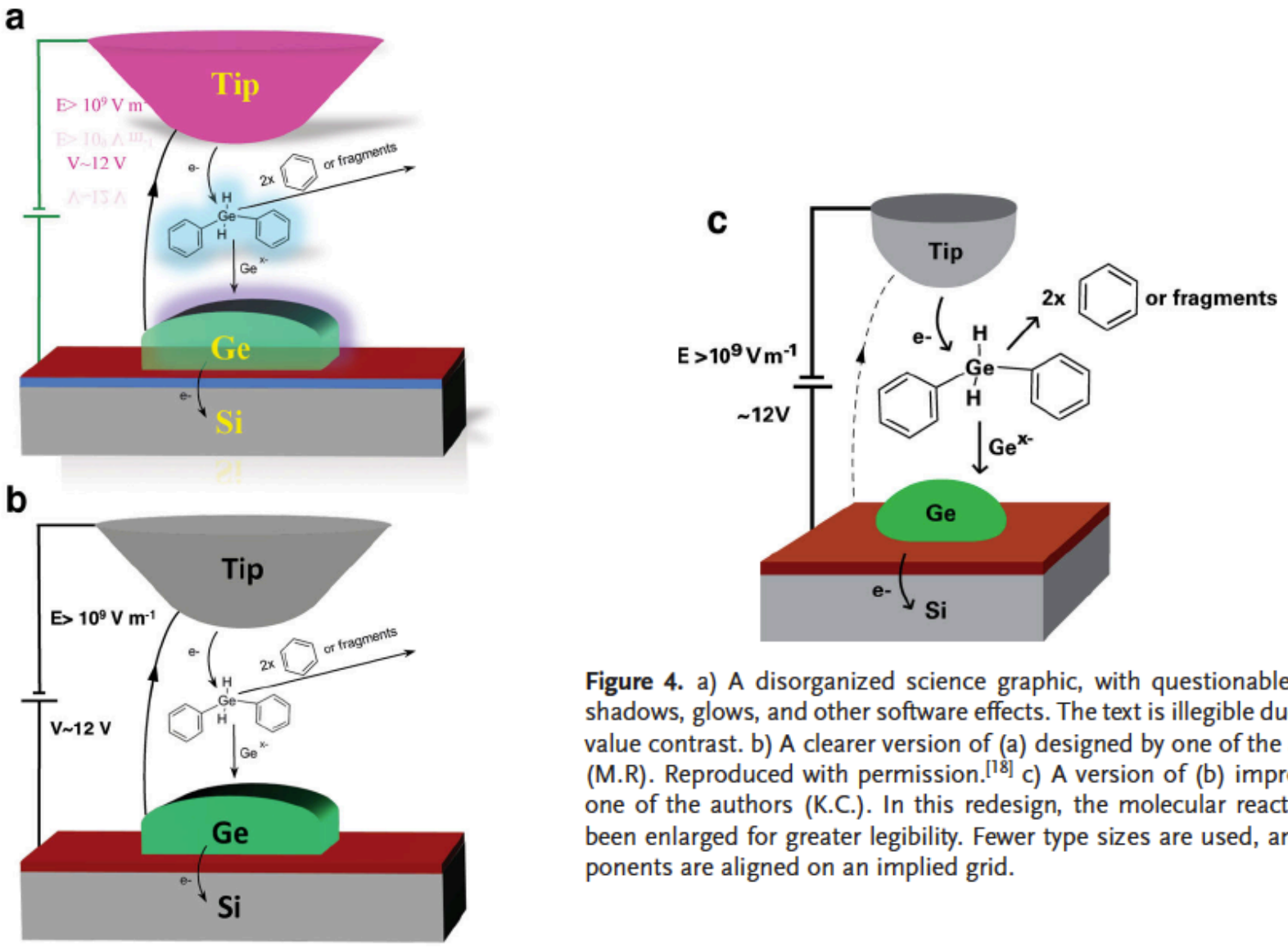
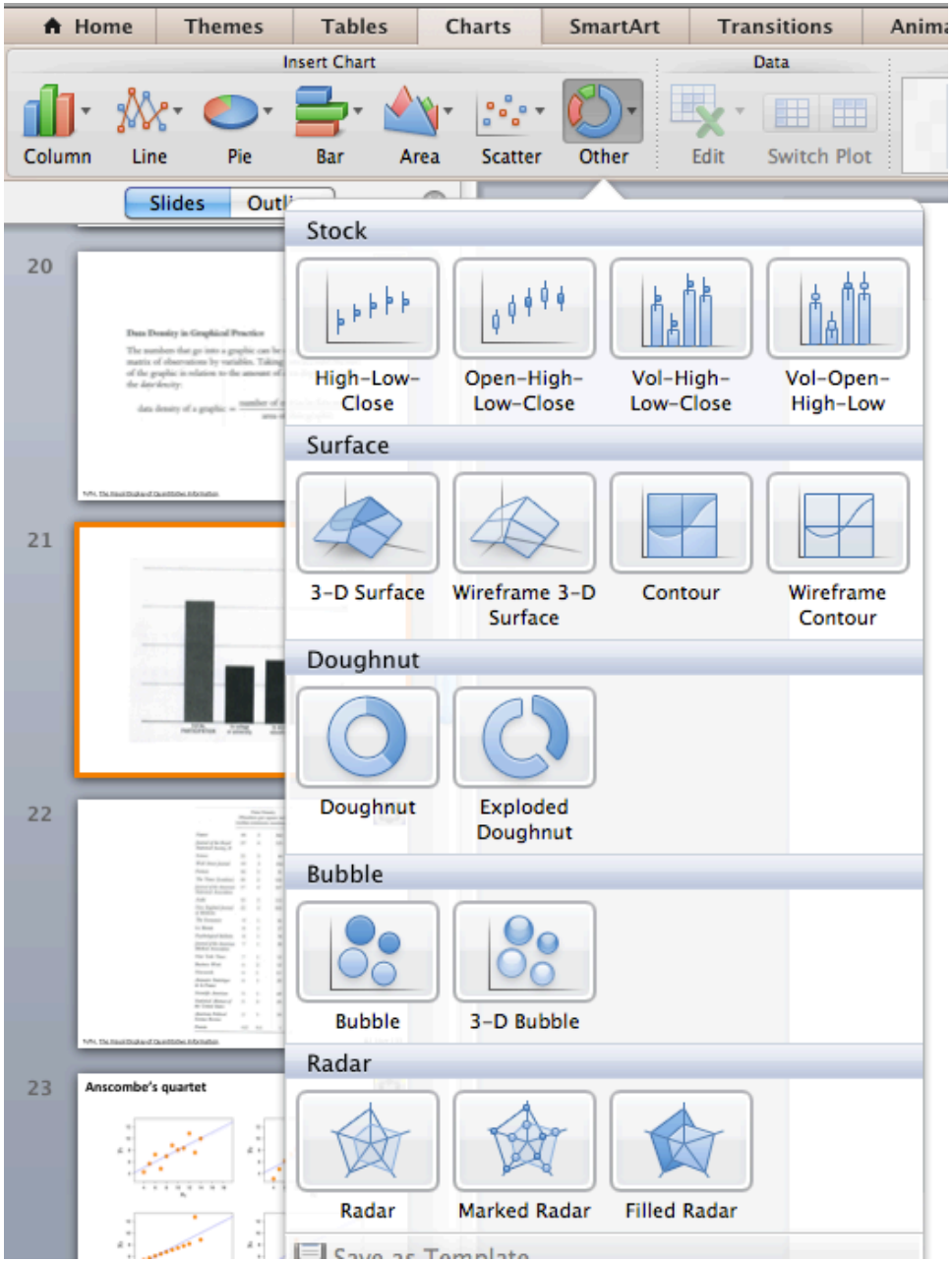
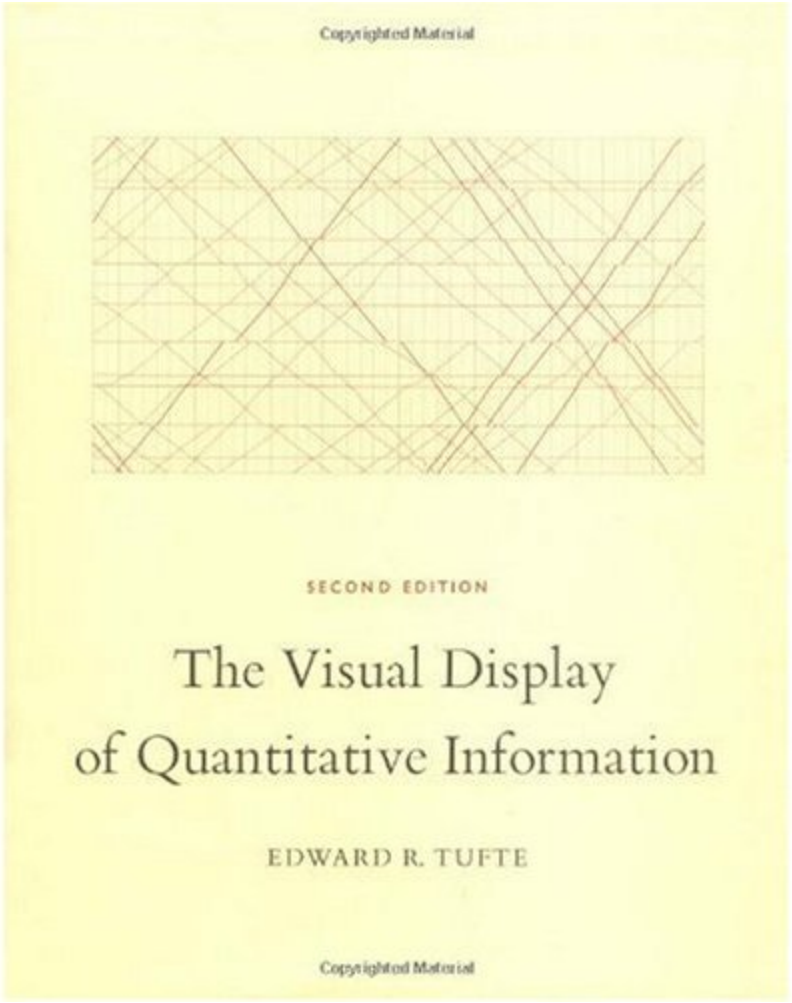


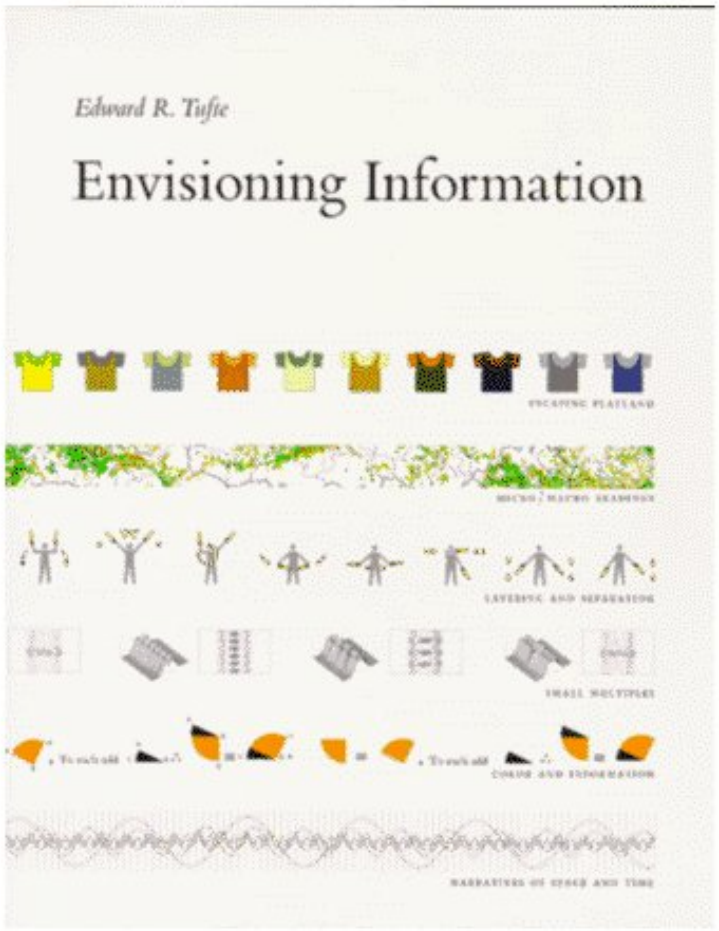
Figure 4. a) A disorganized science graphic, with questionable use of shadows, glows, and other software effects. The text is illegible due to low value contrast. b) A clearer version of (a) designed by one of the authors (M.R). Reproduced with permission.[18] c) A version of (b) improved by one of the authors (K.C.). In this redesign, the molecular reaction has been enlarged for greater legibility. Fewer type sizes are used, and components are aligned on an implied grid.

Too many options!

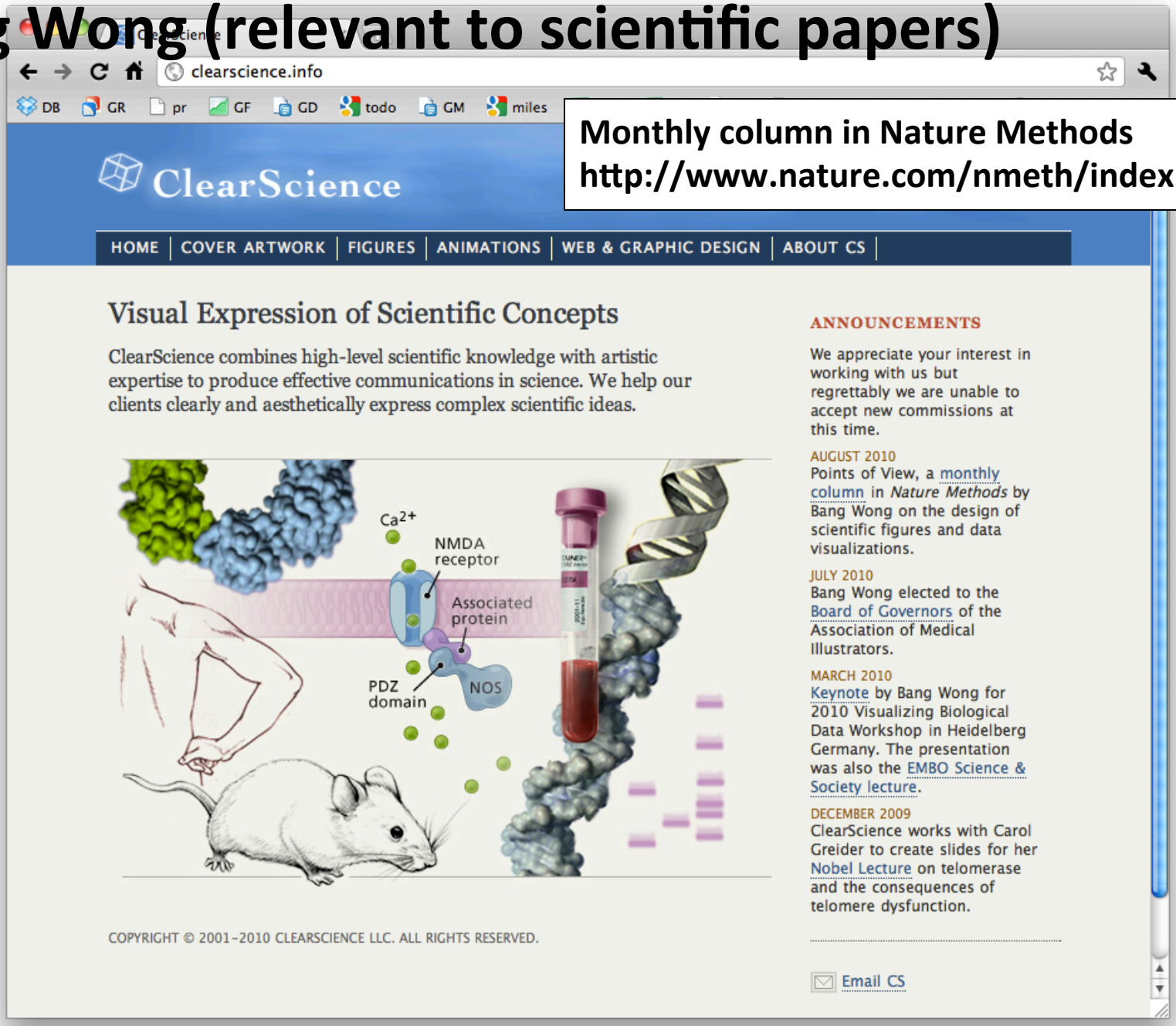


Edward Tufte (philosophy of displaying info)



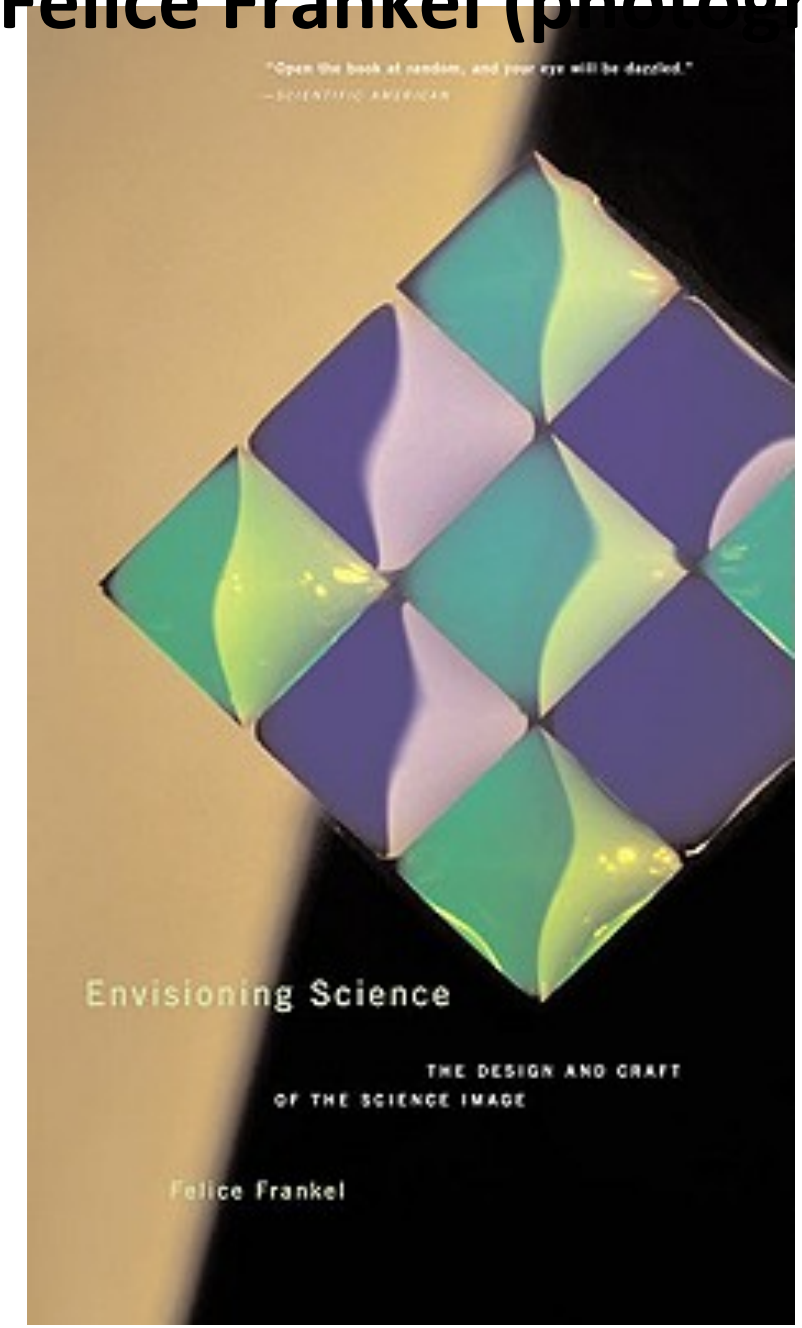


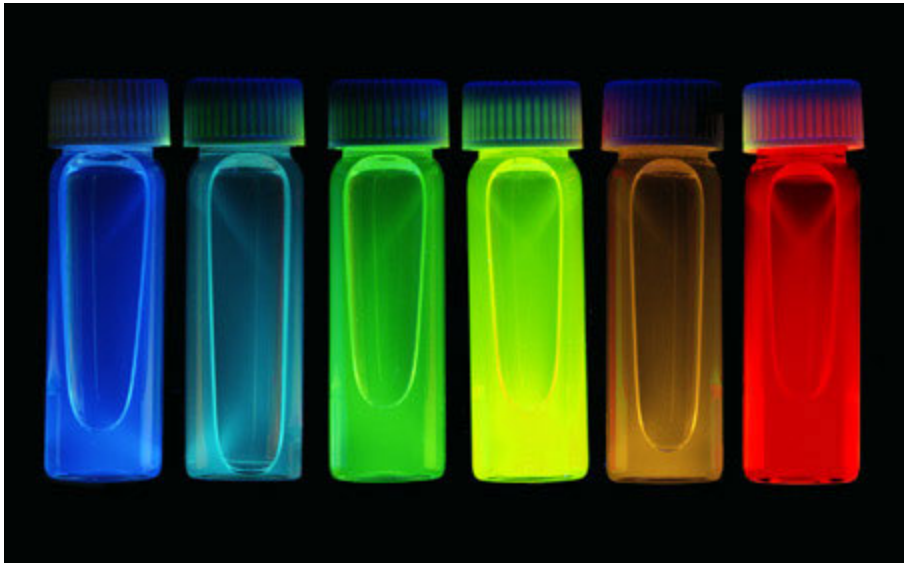
Bang Wong (relevant to scientific papers)



Monthly column in Nature Methods
http://www.nature.com/nmeth/index.html

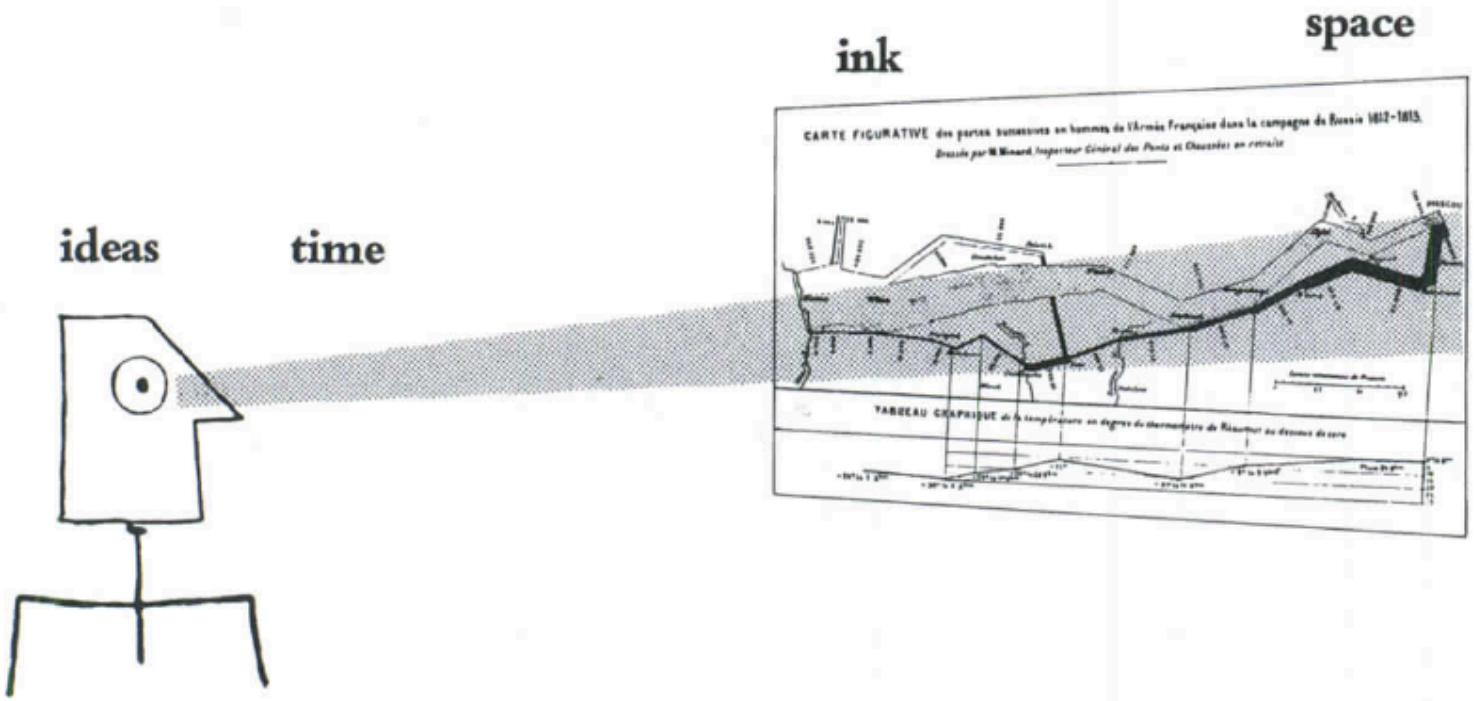
Felice Frankel (photography)





Felice Frankel

Graphical excellence is that which gives to the viewer the greatest number of ideas in the shortest time with the least ink in the smallest space.



Tufte, The Visual Display of Quantitative Information.

Tufte's compositional principles - good figures should

- Have properly chosen format and design
- Use words, numbers, and drawing together
- Reflect a balance, a proportion, a sense of relevant scale
- Display an accessible complexity of detail
- Have a story to tell about the data
- Be drawn in a professional manner
- Avoid content-free decoration ("chartjunk")

Tufte, The Visual Display of Quantitative Information.

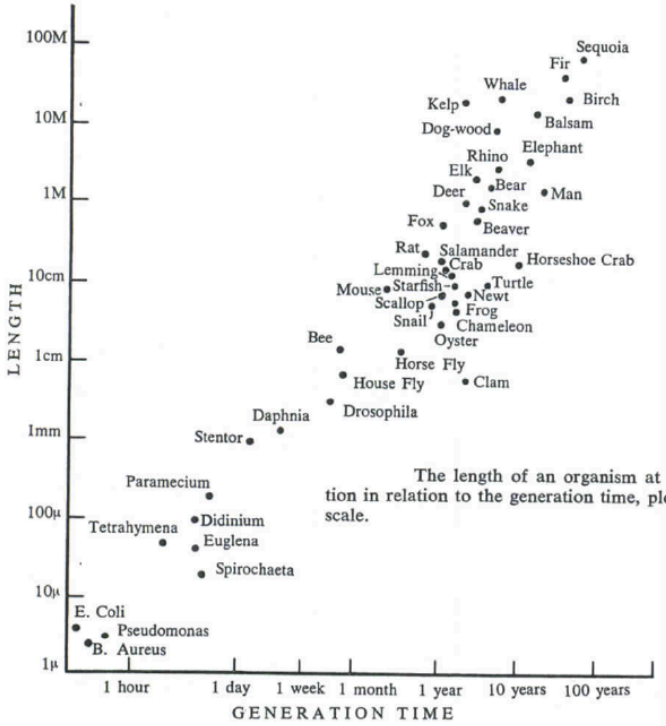
$$\text{Data-ink ratio} = \frac{\text{data-ink}}{\text{total ink used to print the graphic}}$$

$$= \text{proportion of a graphic's ink devoted to the non-redundant display of data-information}$$

$$= 1.0 - \text{proportion of a graphic that can be erased without loss of data-information.}$$

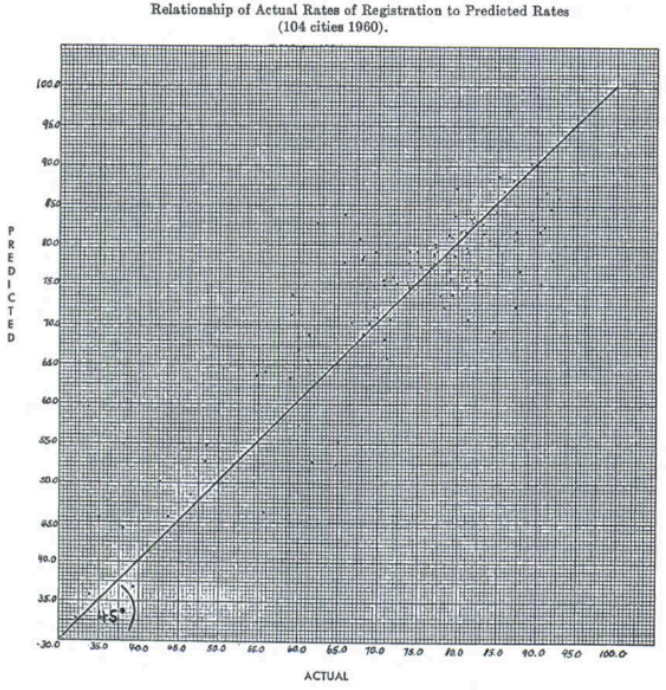
Tufte, The Visual Display of Quantitative Information.

Most of the ink in this graphic is data-ink (the dots and labels on the diagonal), with perhaps 10–20 percent non-data-ink (the grid ticks and the frame):

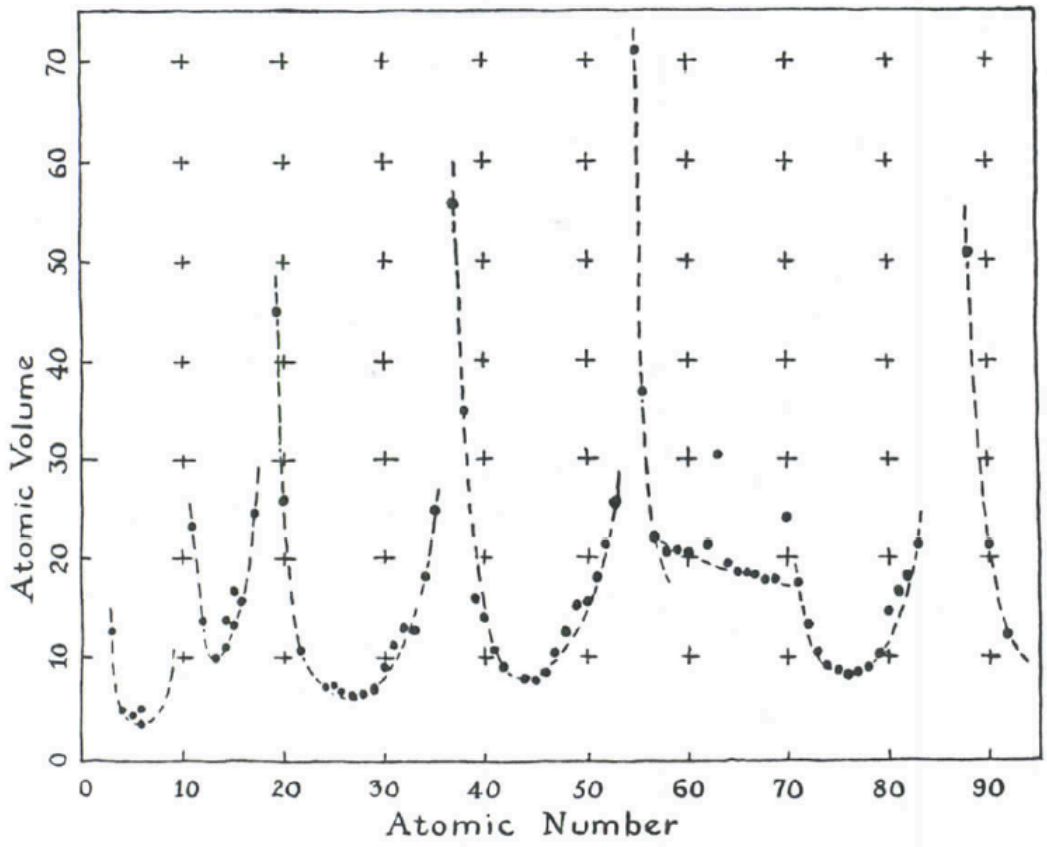


The length of an organism at the time of reproduction in relation to the generation time, plotted on a logarithmic scale.

In this display with nearly all its ink devoted to matters other than data, the grid sea overwhelms the numbers (the faint points scattered about the diagonal):

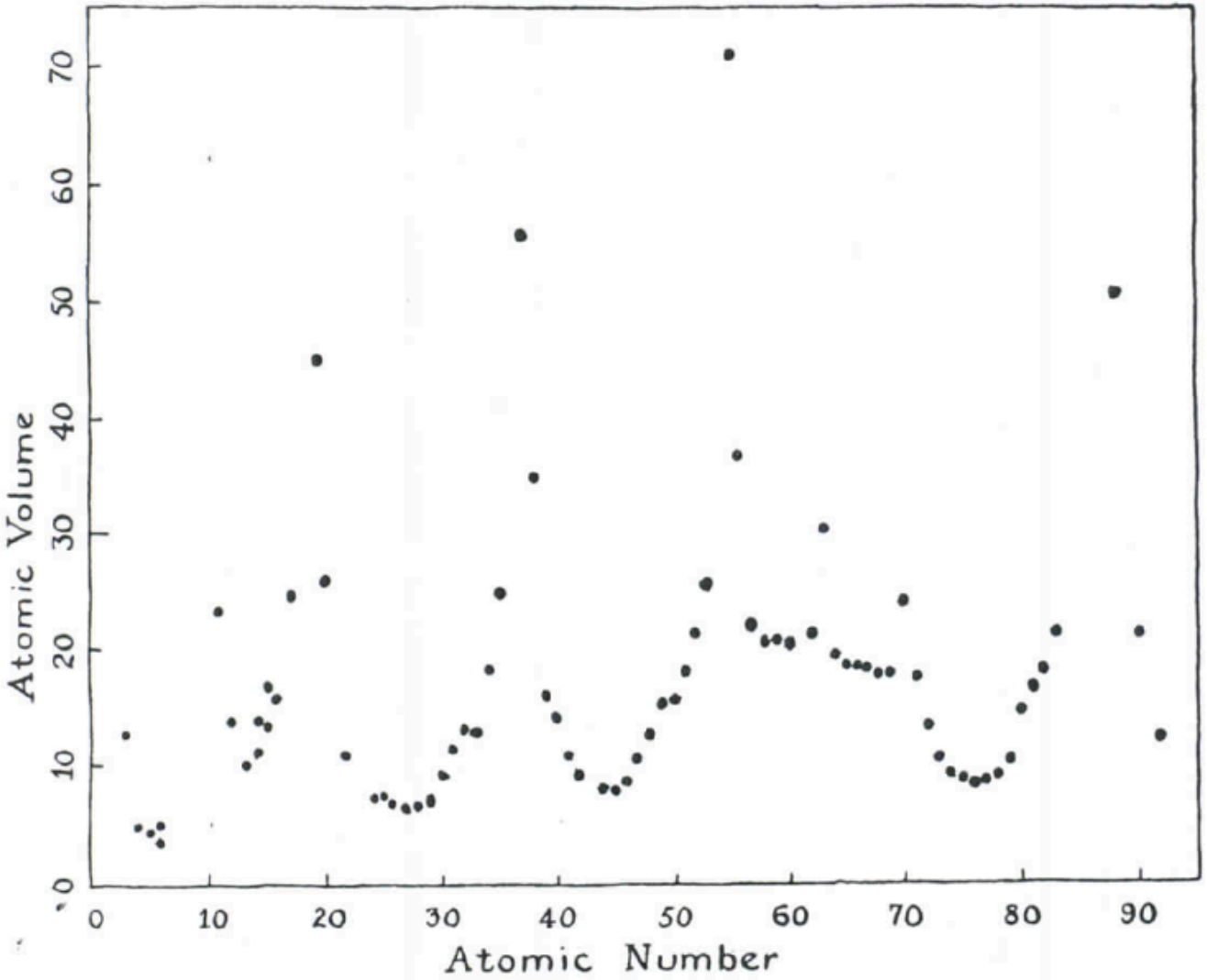


The next graphic, drawn by the distinguished science illustrator Roger Hayward, shows the periodicity of properties of chemical elements, exemplified by atomic volume as a function of atomic number. The data-ink ratio is less than 0.6, lowered because the 76 data points and the reference curves are obscured by the 63 dark grid marks arrayed over the data plane like a precision marching band of 63 mosquitoes:



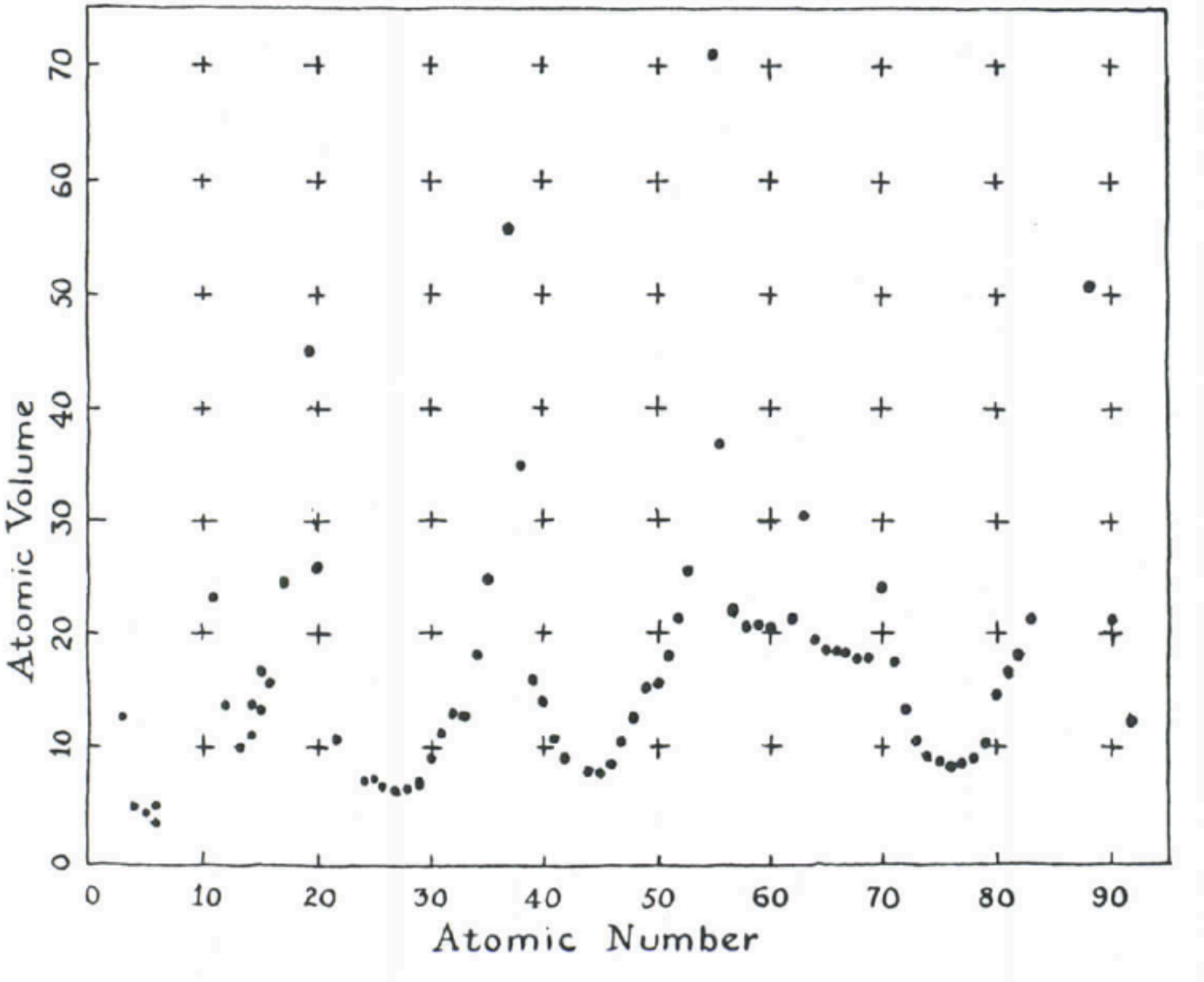
Tufte, The Visual Display of Quantitative Information.

No grid, no guides



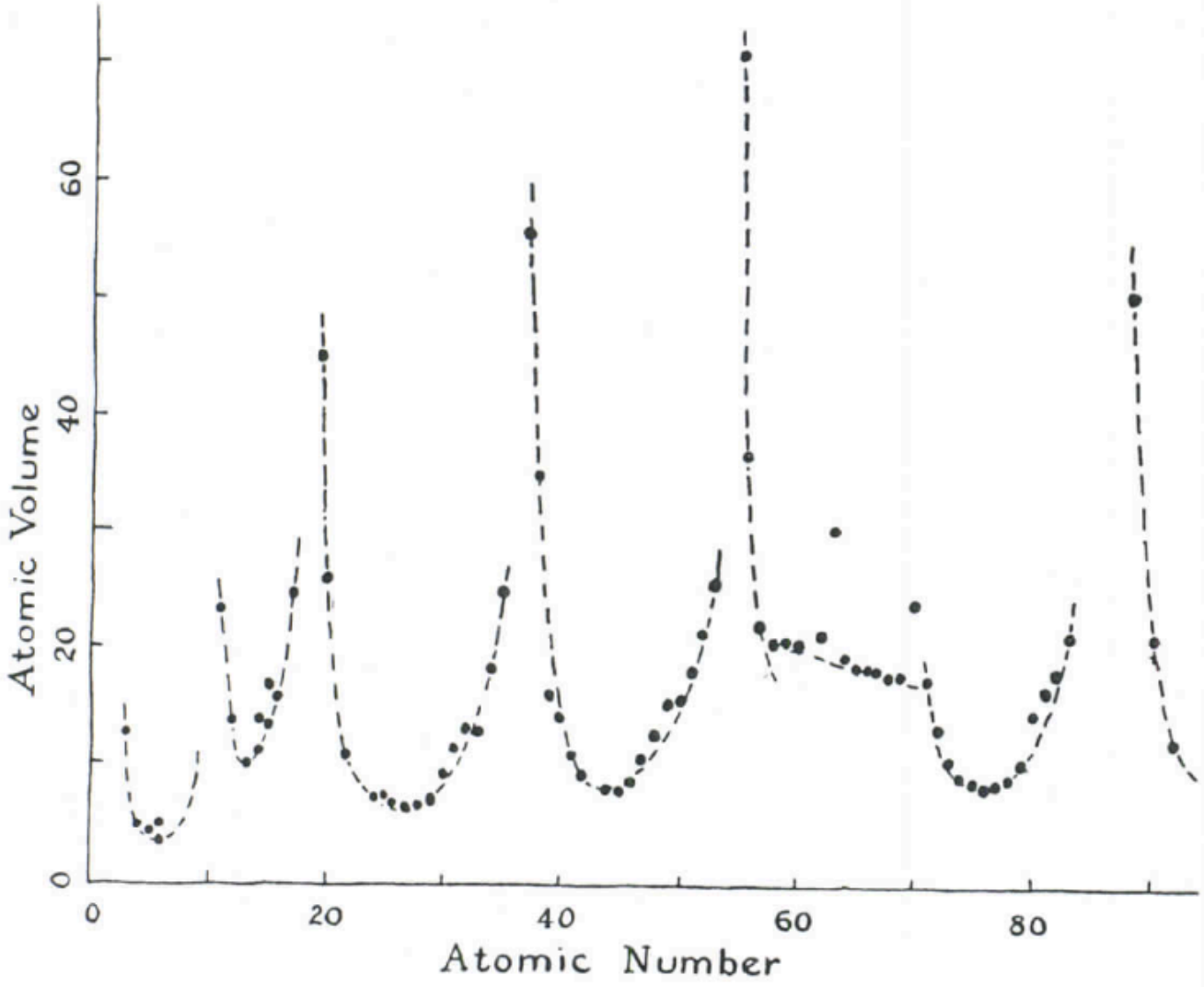
Tufte, The Visual Display of Quantitative Information.

Grid, no guides



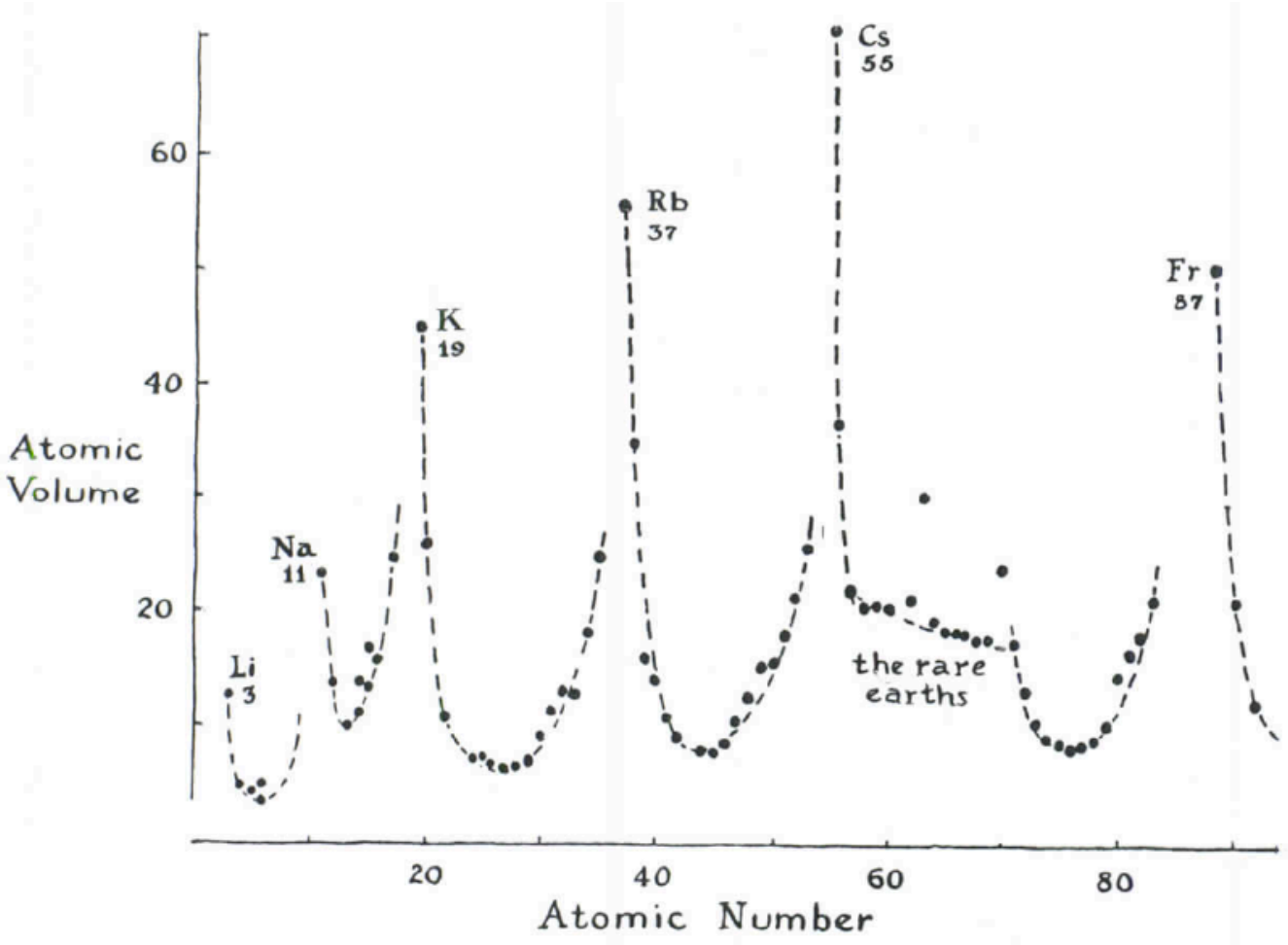
Tufte, The Visual Display of Quantitative Information.

Guides, no grid



Tufte, The Visual Display of Quantitative Information.

A bit more



Tufte, The Visual Display of Quantitative Information.

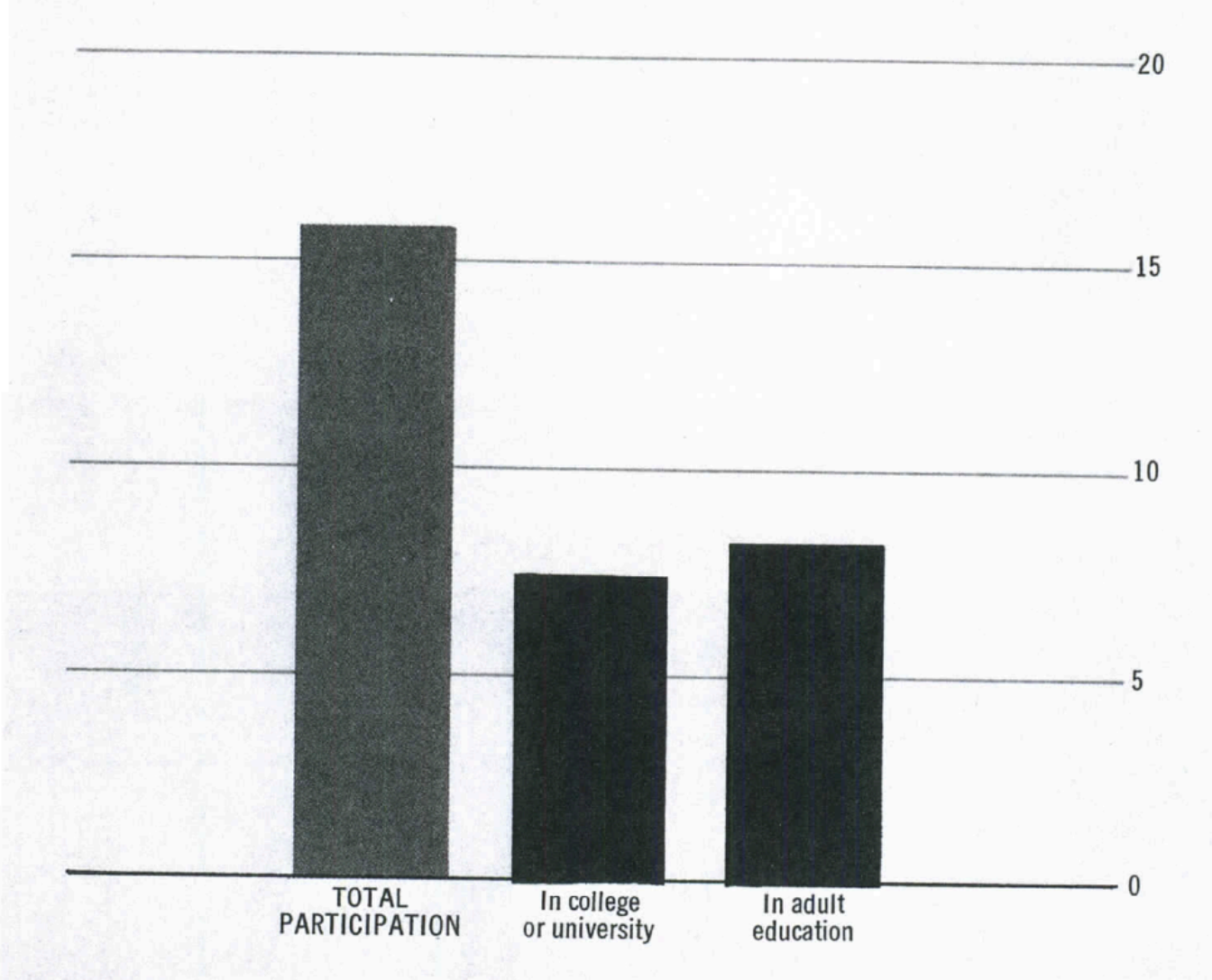
Data Density in Graphical Practice

The numbers that go into a graphic can be organized into a data matrix of observations by variables. Taking into account the size of the graphic in relation to the amount of data displayed yields the *data density*:

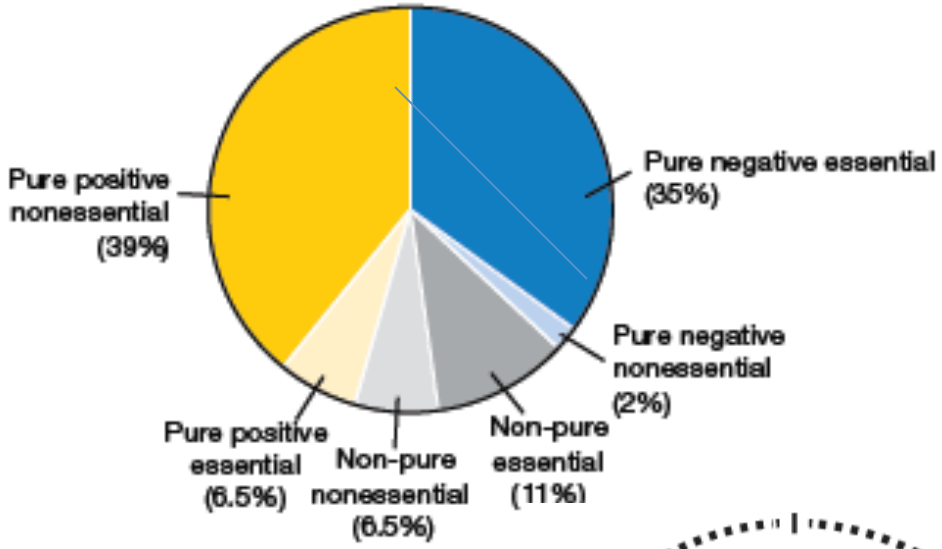
$$\text{data density of a graphic} = \frac{\text{number of entries in data matrix}}{\text{area of data graphic}}$$

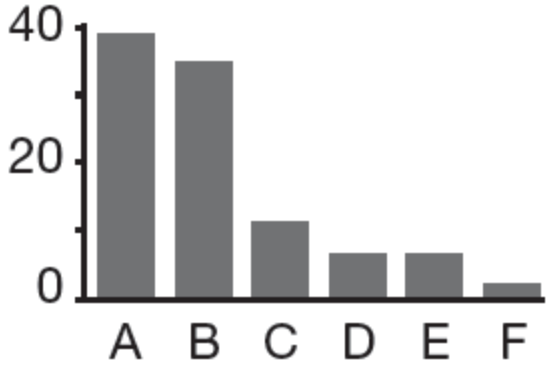
Tufte, The Visual Display of Quantitative Information.

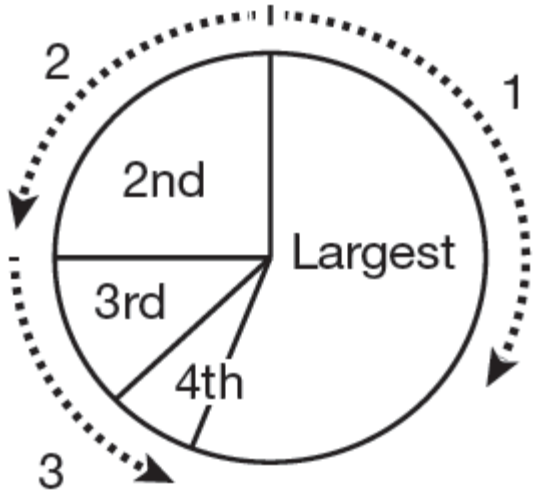
Is this enough data for a figure?



Tufte: "Given their low data density and failure to order numbers along a visual dimension, pie charts should never be used"







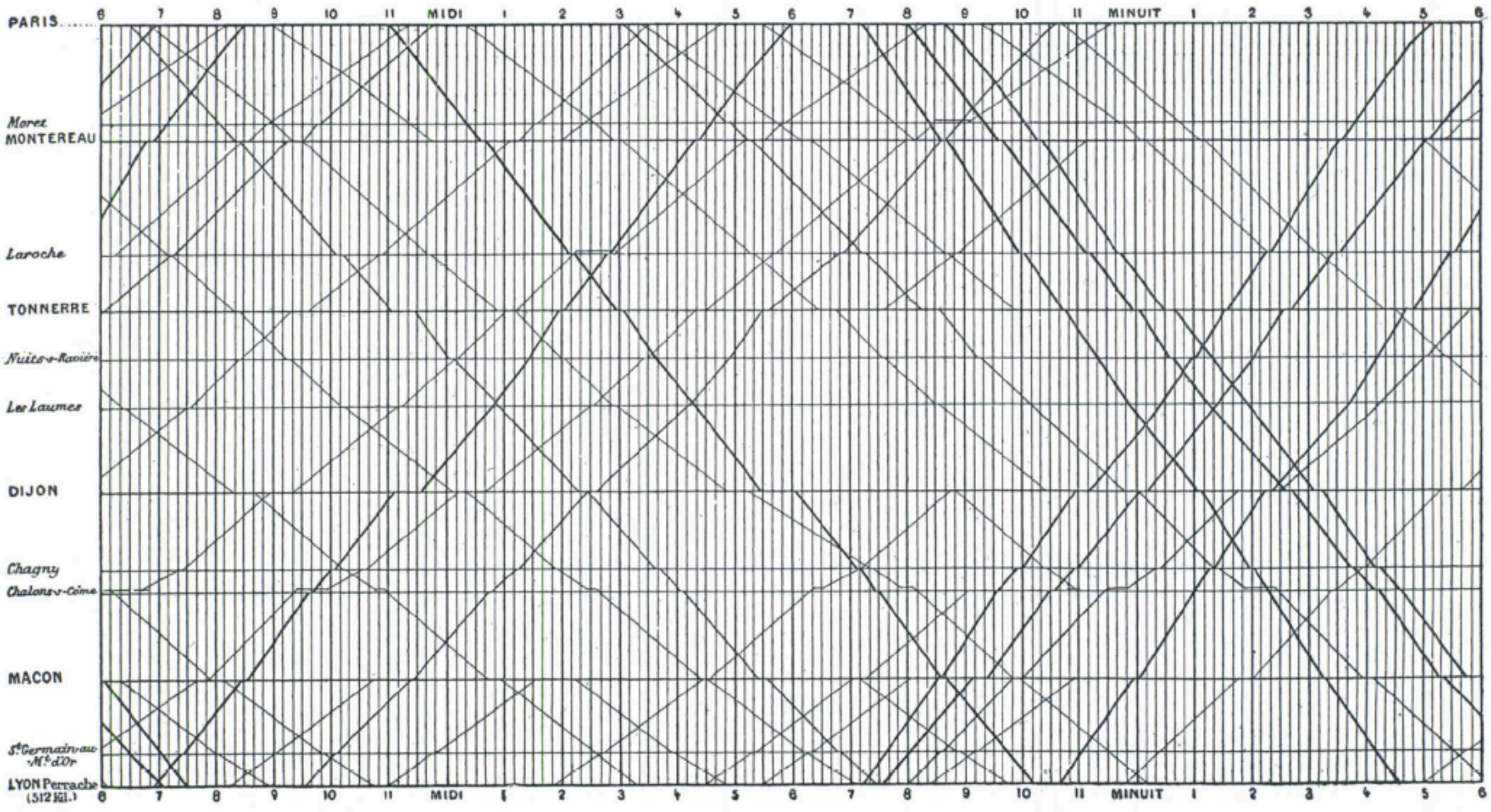
But, if a simple graphic is necessary pay attention to how you organize the data

Wong. *Nature Methods* 8(3):189, 2011.

	Data Density (Numbers per square inch) median	minimum	maximum
Nature	48	3	362
Journal of the Royal Statistical Society, B	27	4	115
Science	21	5	44
Wall Street Journal	19	3	154
Fortune	18	5	31
The Times (London)	18	2	122
Journal of the American Statistical Association	17	4	167
Asahi	13	2	113
New England Journal of Medicine	12	3	923
The Economist	9	1	51
Le Monde	8	1	17
Psychological Bulletin	8	1	74
Journal of the American Medical Association	7	1	39
New York Times	7	1	13
Business Week	6	2	12
Newsweek	6	1	13
Annuaire Statistique de la France	6	1	25
Scientific American	5	1	69
Statistical Abstract of the United States	5	2	23
American Political Science Review	2	1	10
Pravda	0.2	0.1	1

Tufte, The Visual Display of Quantitative Information.

Example of high a data density figure with useful gridlines

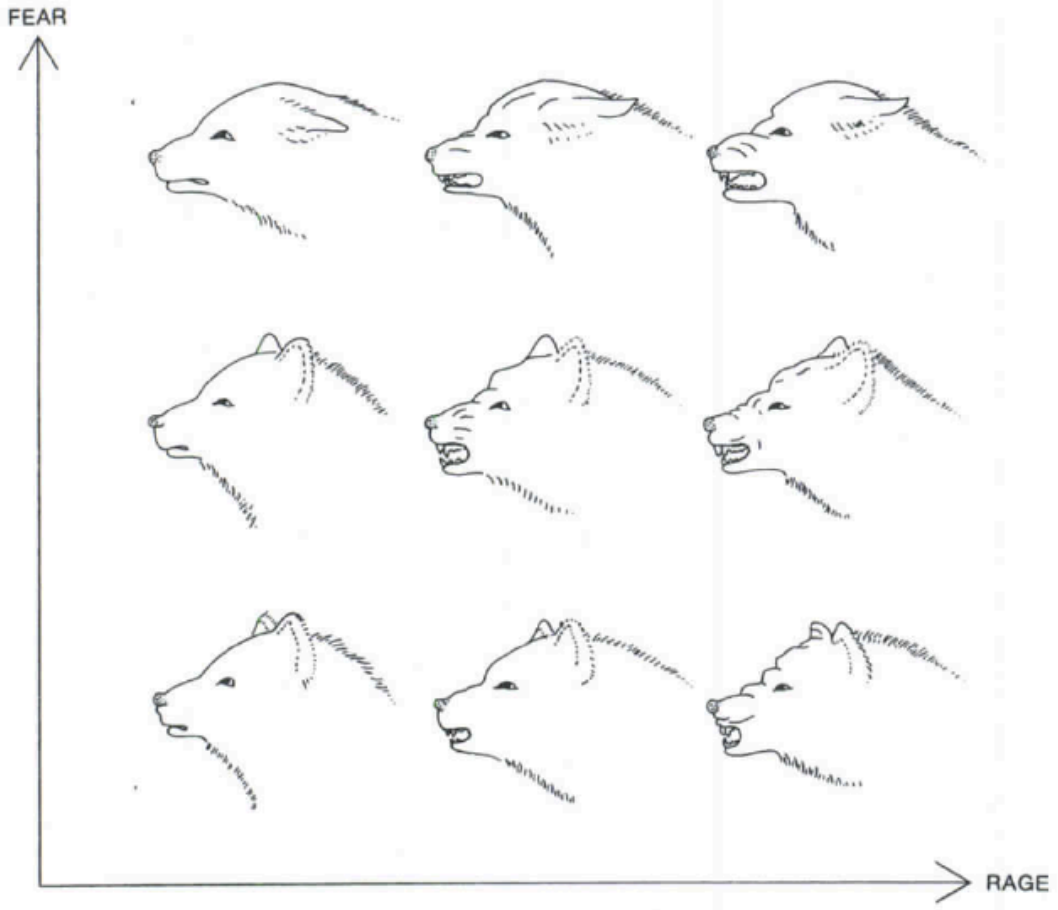


E. J. Marey, *La Méthode Graphique* (Paris, 1885), p. 20. The method is attributed to the French engineer, Ibry.

Tufte, The Visual Display of Quantitative Information.

Relating variables using pictures

Finally, two relational designs of a different sort—wherein the data points are themselves data. Here the effect of two variables interacting is portrayed by the faces on the plotting field:

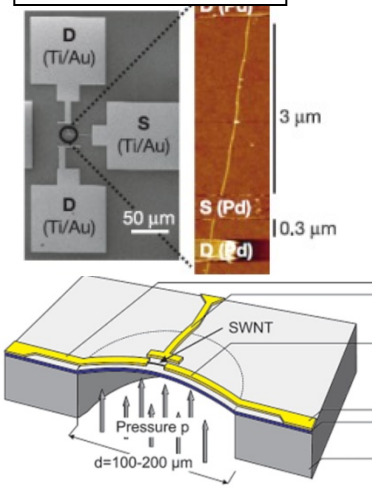


Tufte, The Visual Display of Quantitative Information.

Configurations

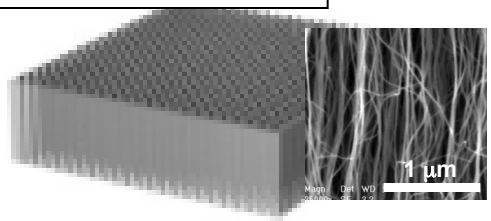
Order = quality, purity, alignment
Quantity = #/volume

individual

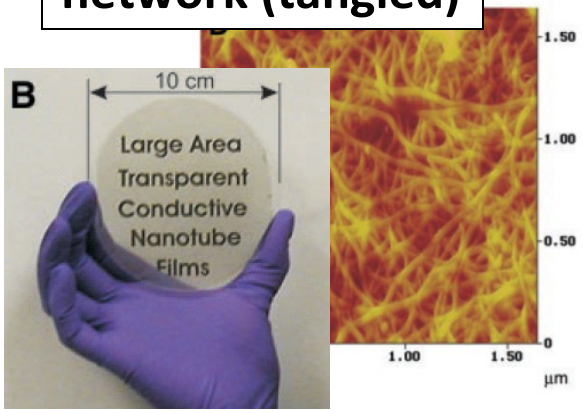


Stanford, ETH

forest (aligned)

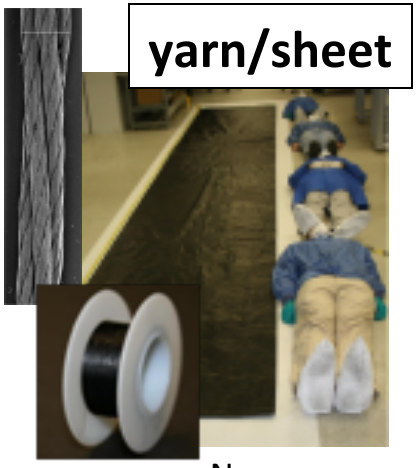


network (tangled)



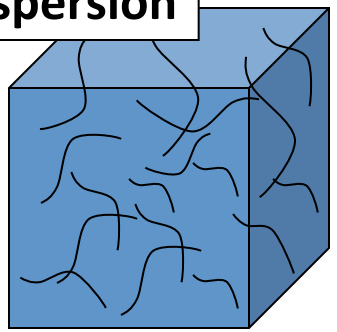
Florida

yarn/sheet



Nanocomp

dispersion



Order: high / low

Quantity [#/vol]: few / many

Elements of figure composition and style

- Color coding
- Text
- Lines, axes, and arrows
- Alignment and grouping
- Choice of shape
- Drawings / images
- Negative space!

Color transitions are not perceived equally

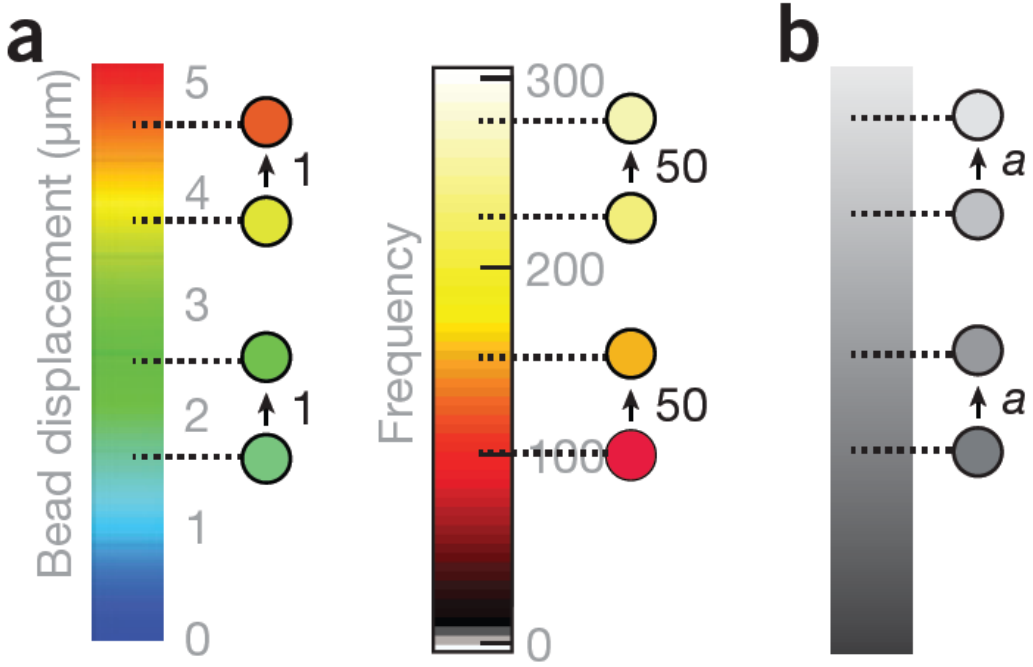
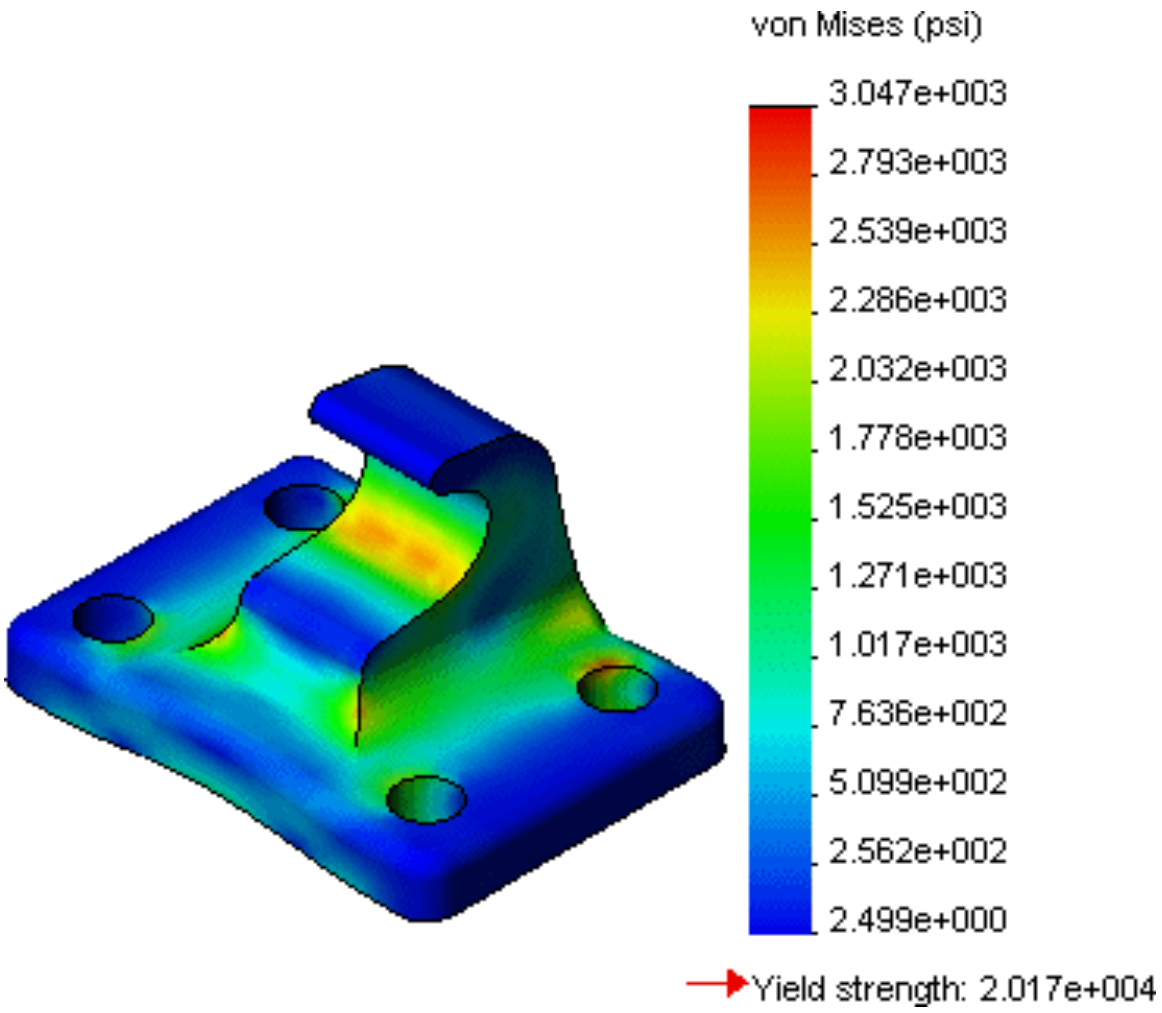


Figure 2 | Color is not ideal for presenting quantitative data. (**a**) Shifts in color scales (circles) are not visually commensurate with change in value. Reprinted from *Nature Methods*[2,5]. (**b**) A gradation from 10–90% black produces even transitions.

Wong. *Nature Methods* 8(3):189, 2011.

This is really relevant to ME



Choosing color scales

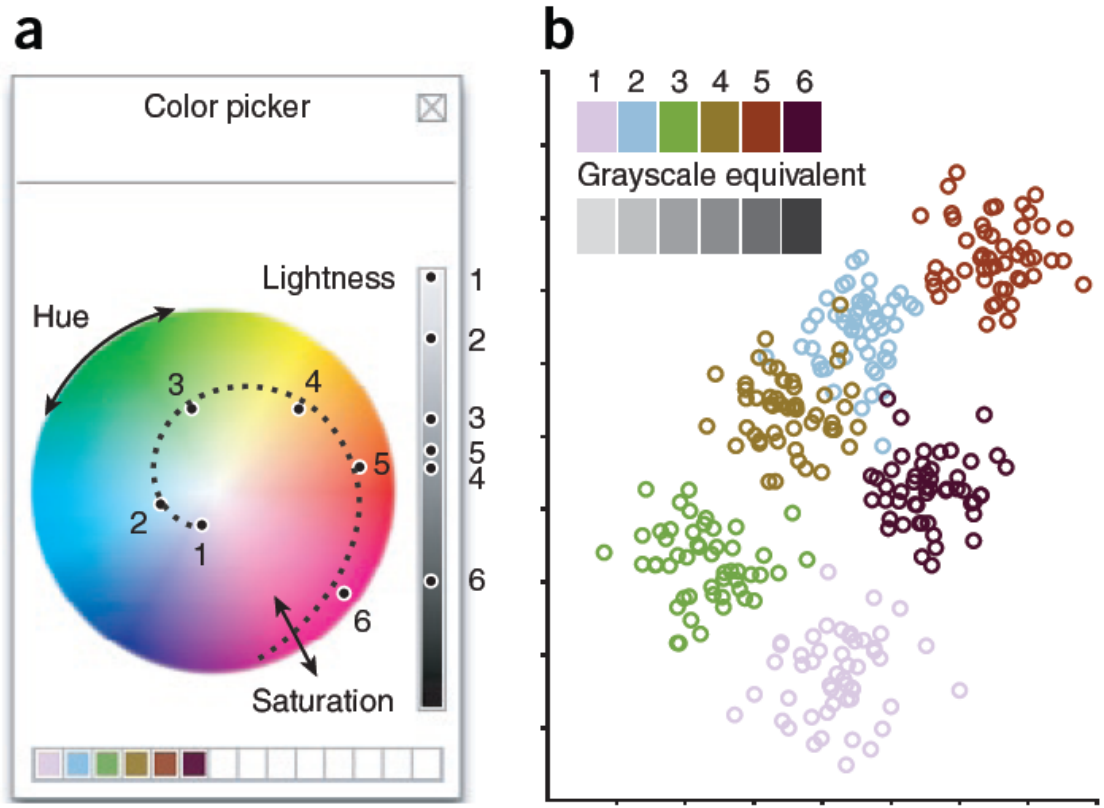


Figure 2 | Color has hue, saturation and brightness. (**a**,**b**) Colors can be tuned using a color picker (**a**). Spiraling through hue and saturation while varying lightness can generate a discernible color set distinguishable even in grayscale (points labeled 1–6).

Wong. *Nature Methods* 7(8):573, 2010.

Perception of color is based on proximity and surroundings

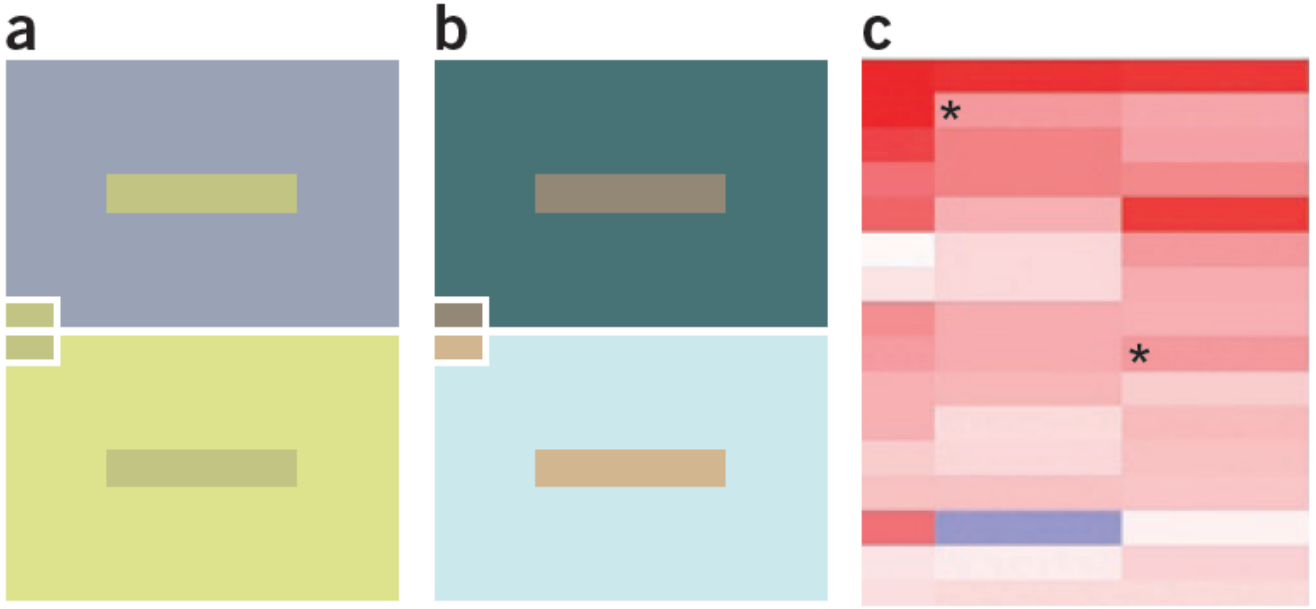


Figure 1 | Perception of color can vary. (**a**,**b**) The same color can look different (**a**), and different colors can appear to be nearly the same by changing the background color (**b**)[1]. (**c**) The rectangles in the heat map indicated by the asterisks (*) are the same color but appear to be different.

Wong. *Nature Methods* 7(8):573, 2010.

Encoding values: make it easy for the reader

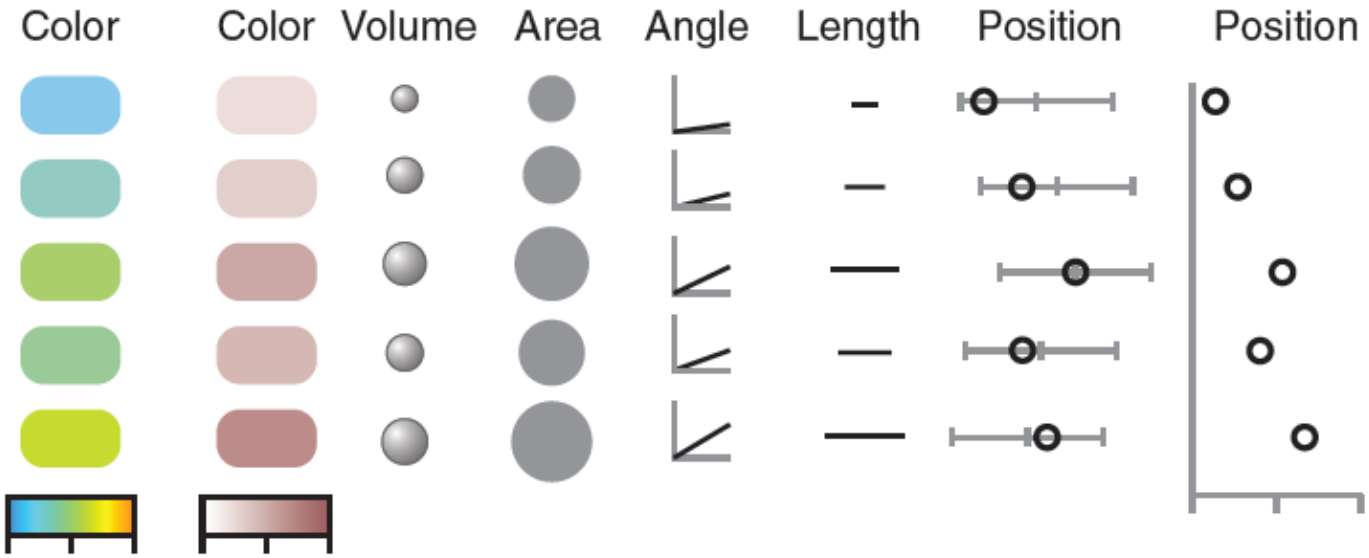


Table 1 | Elementary perceptual tasks

Rank	Aspect to compare
1	Positions on a common scale
2	Positions on the same but nonaligned scales
3	Lengths
4	Angles, slopes
5	Area
6	Volume, color saturation
7	Color hue

Tasks are ordered from most to least accurate. Information adapted from ref. 2.

Wong. *Nature Methods* 7(9):665, 2010.

Alignment

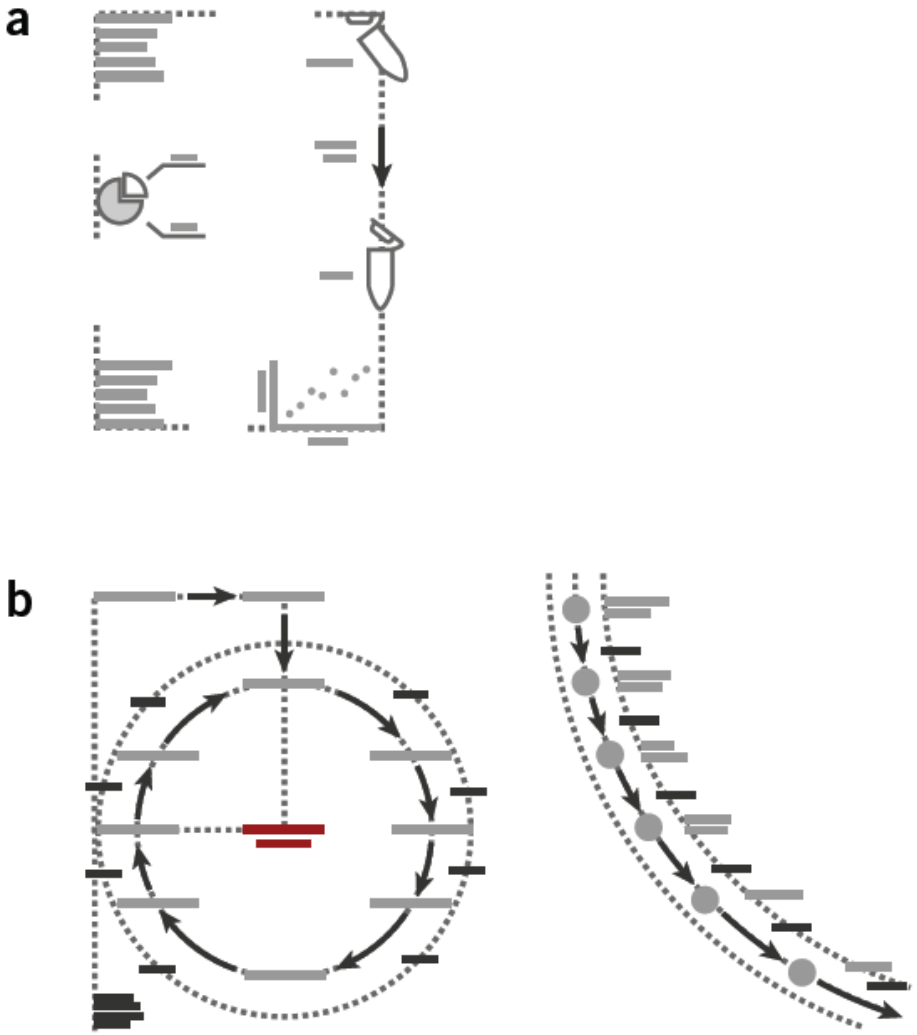
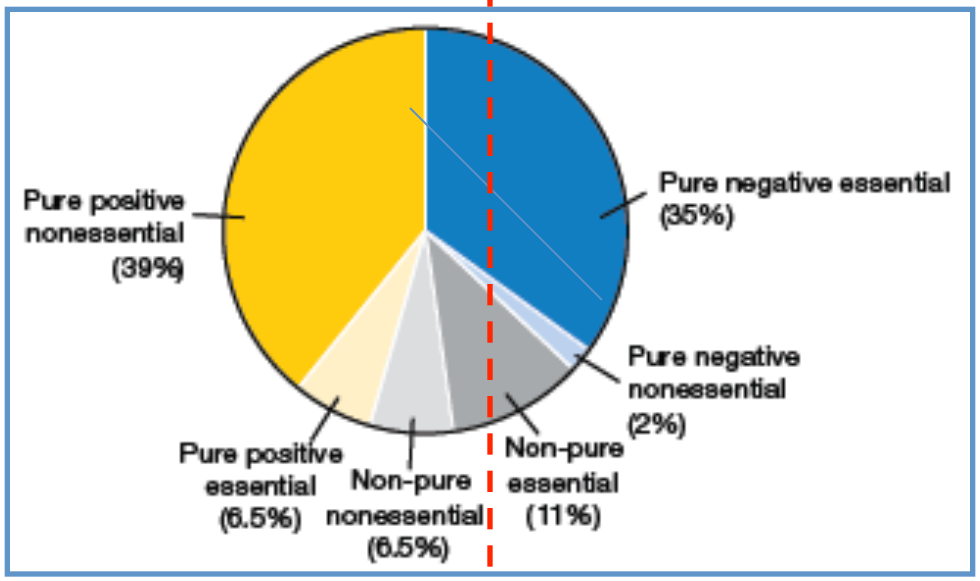
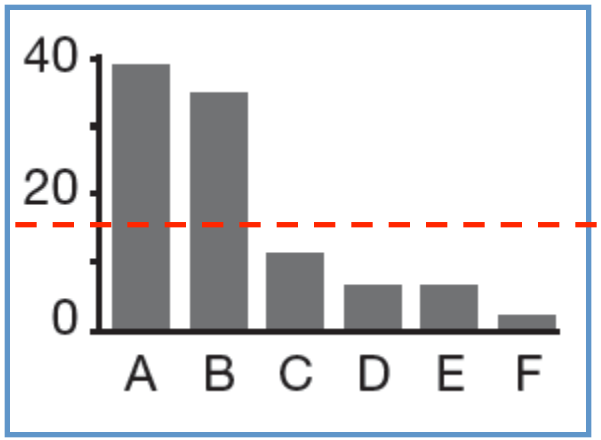


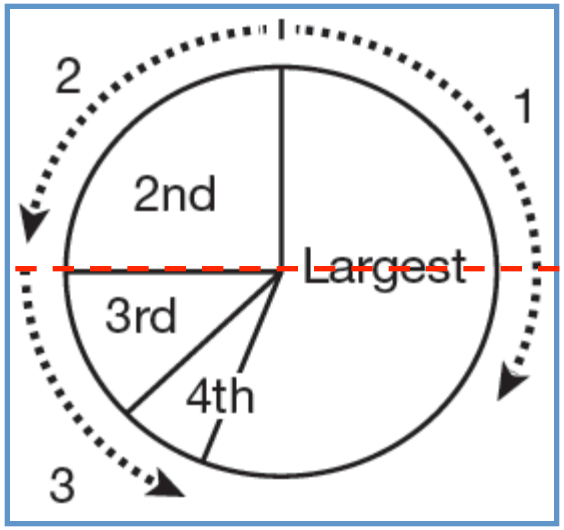
Figure 2 | Alignment. (**a**) Graphics and text used as vertices and edges of geometric shapes. (**b**) Geometric and curvilinear shapes used as flexible guides to align content.

Wong. *Nature Methods* 7(12):941, 2010.

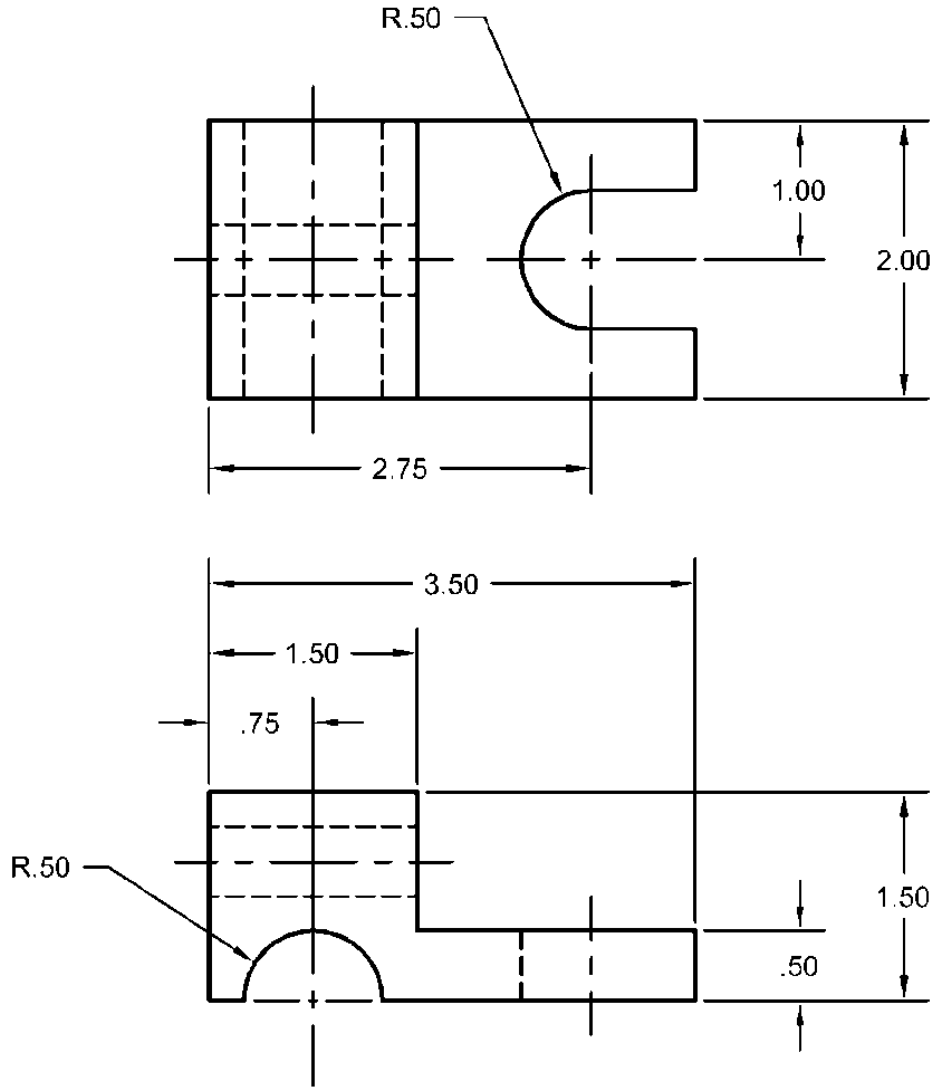
Alignment

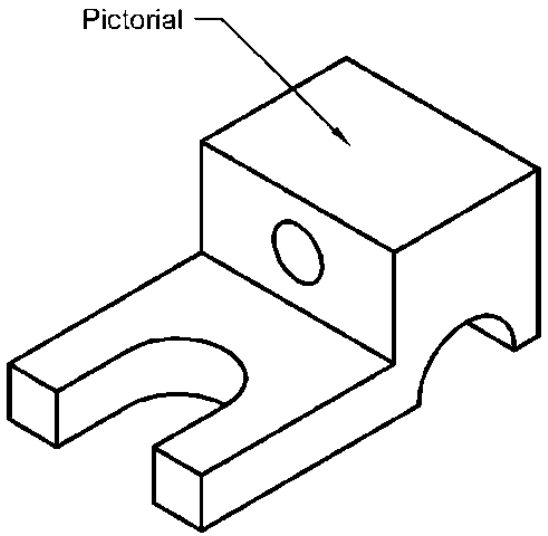

Pure positive nonessential (39%)
Pure negative essential (35%)
Pure negative nonessential (2%)
Non-pure essential (11%)
Non-pure nonessential (6.5%)
Pure positive essential (6.5%)

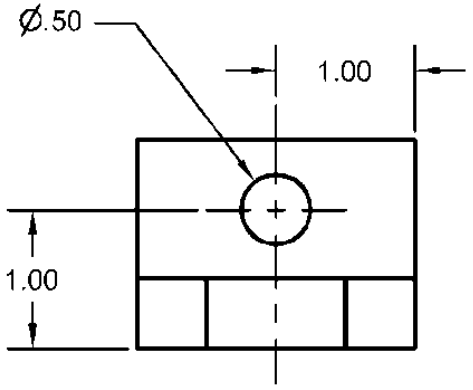

40
20
0
A
B
C
D
E
F


2
1
2nd
Largest
3rd
4th
3

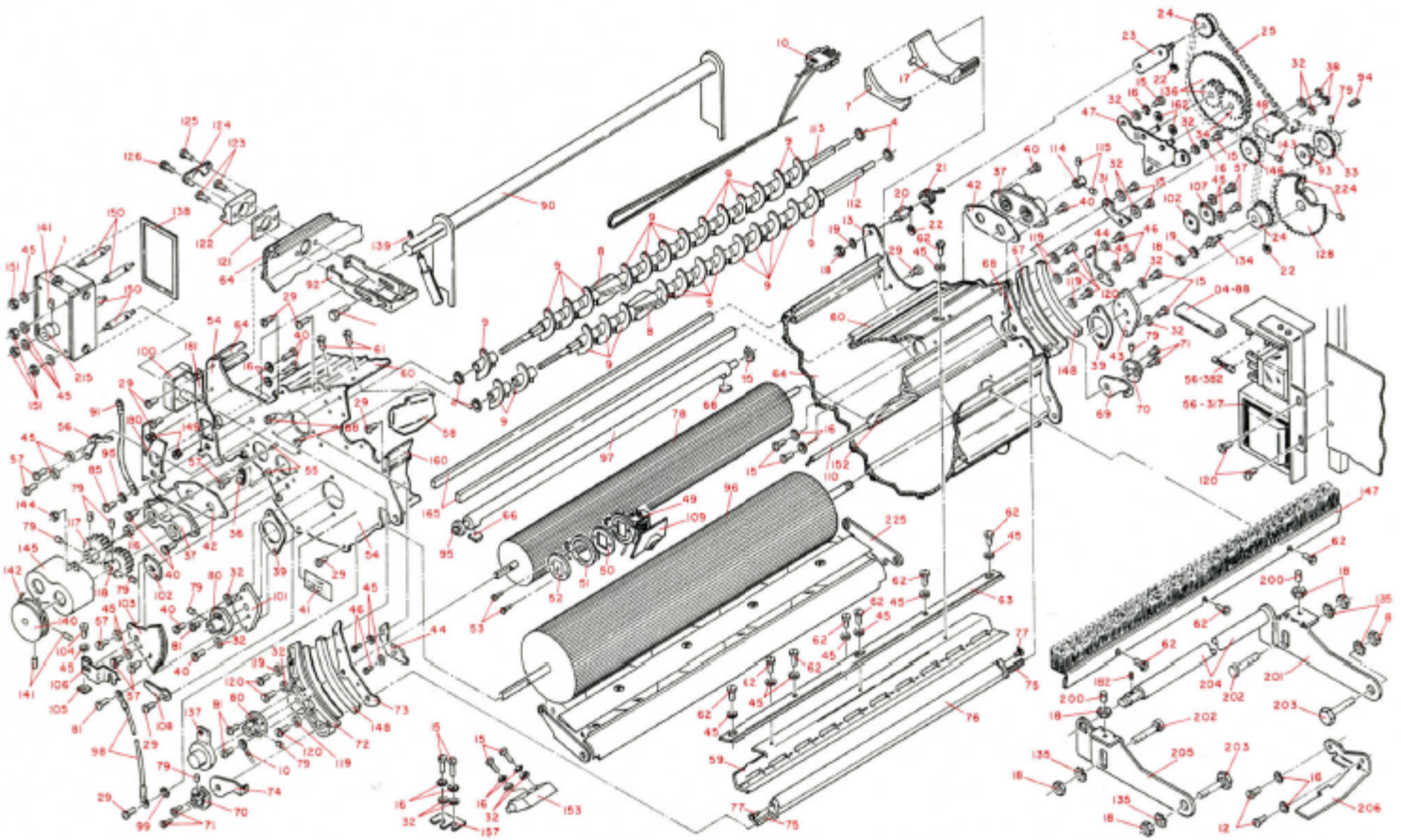
Principles of alignment in mechanical drawings







Color and alignment



Similarly, color effortlessly differentiates between annotation and annotated, in this skillful industrial-strength diagram separating 300 small parts and their identifying numbers.

IBM Series III Copier/Duplicator, Adjustment Parts Manual (Boulder, Colorado, 1976), p. 101. Drawn by Gary E. Graham.

Gestalt principles: grouping and similarity

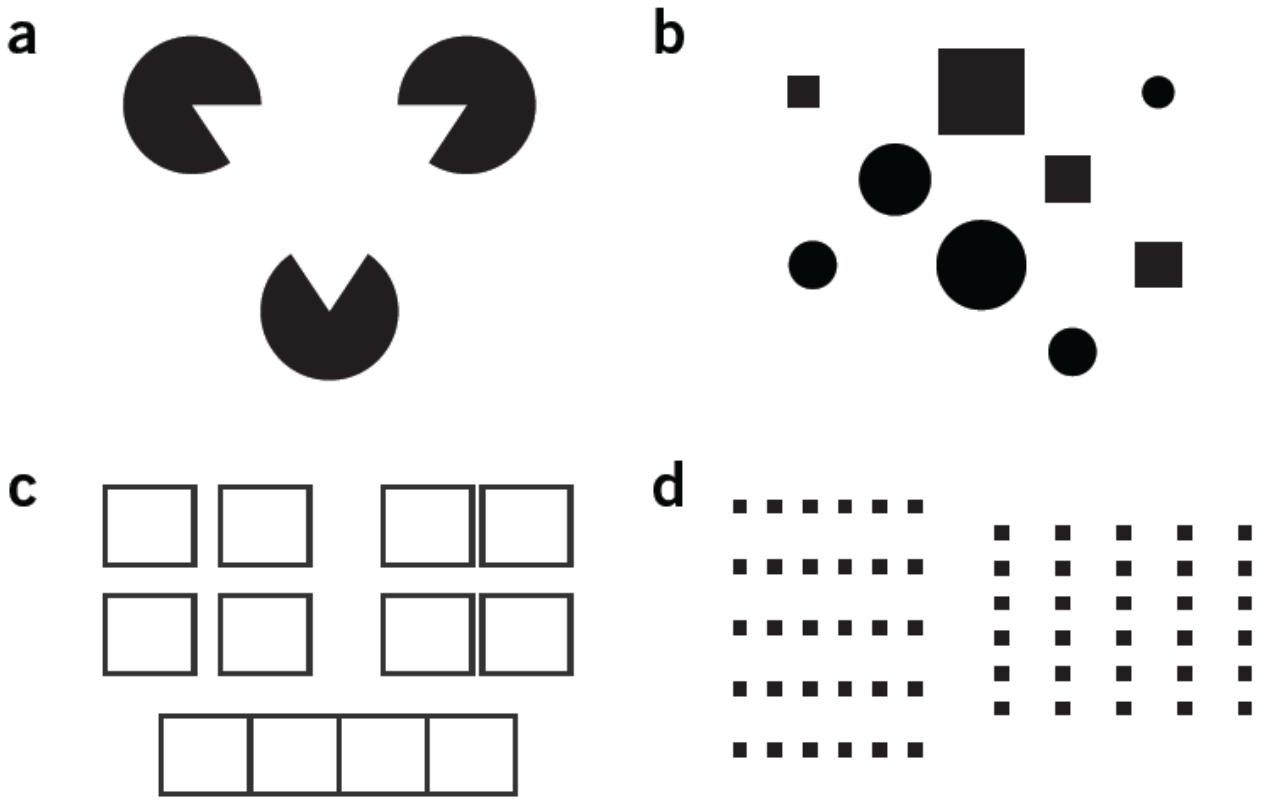
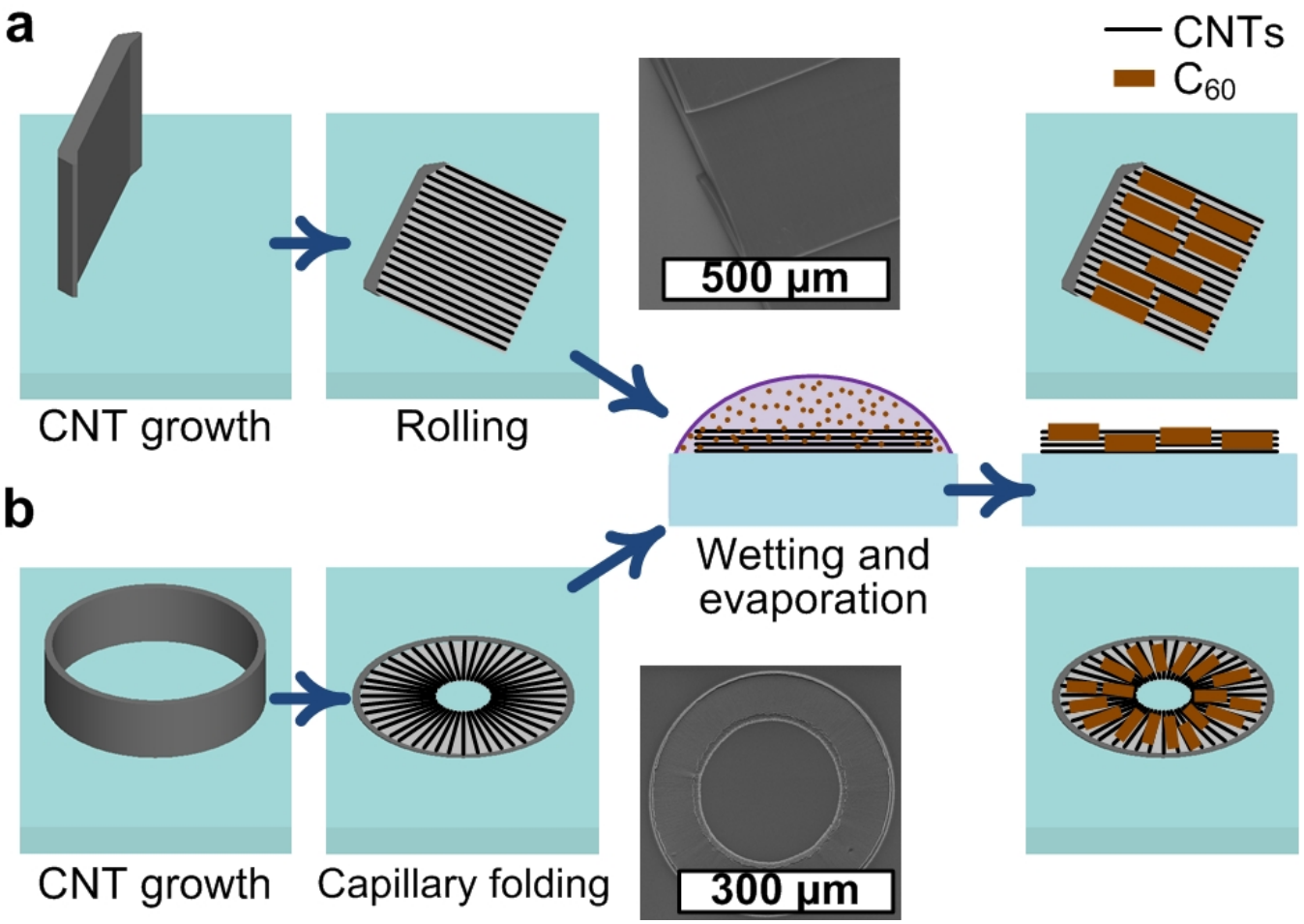
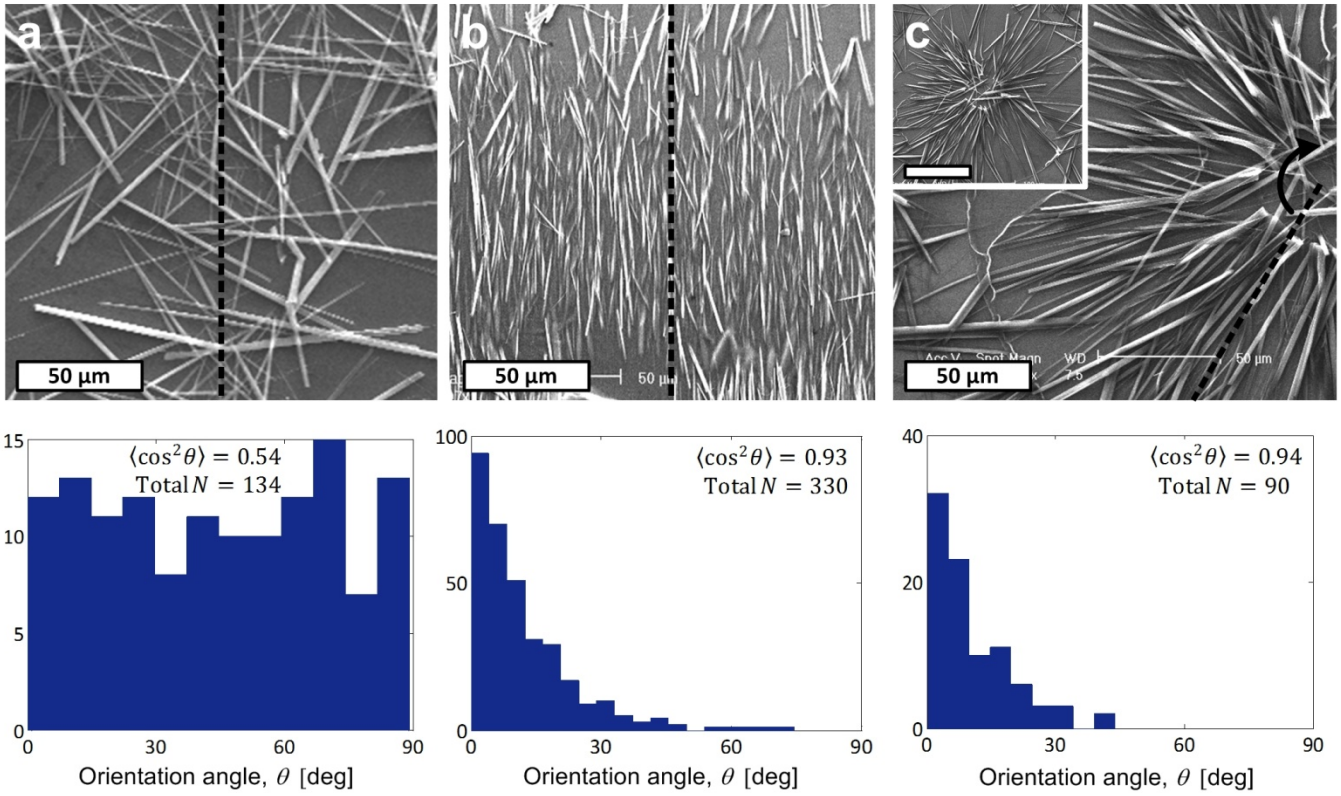
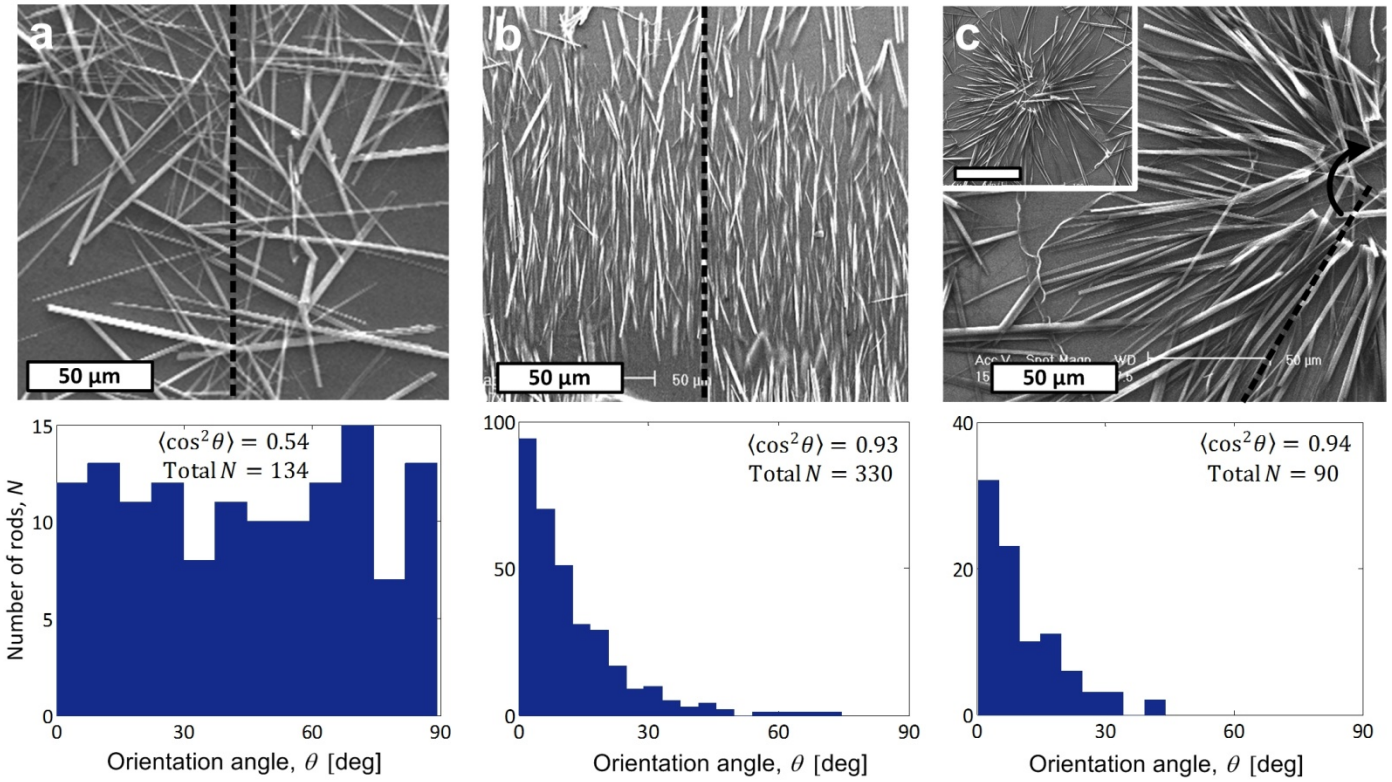


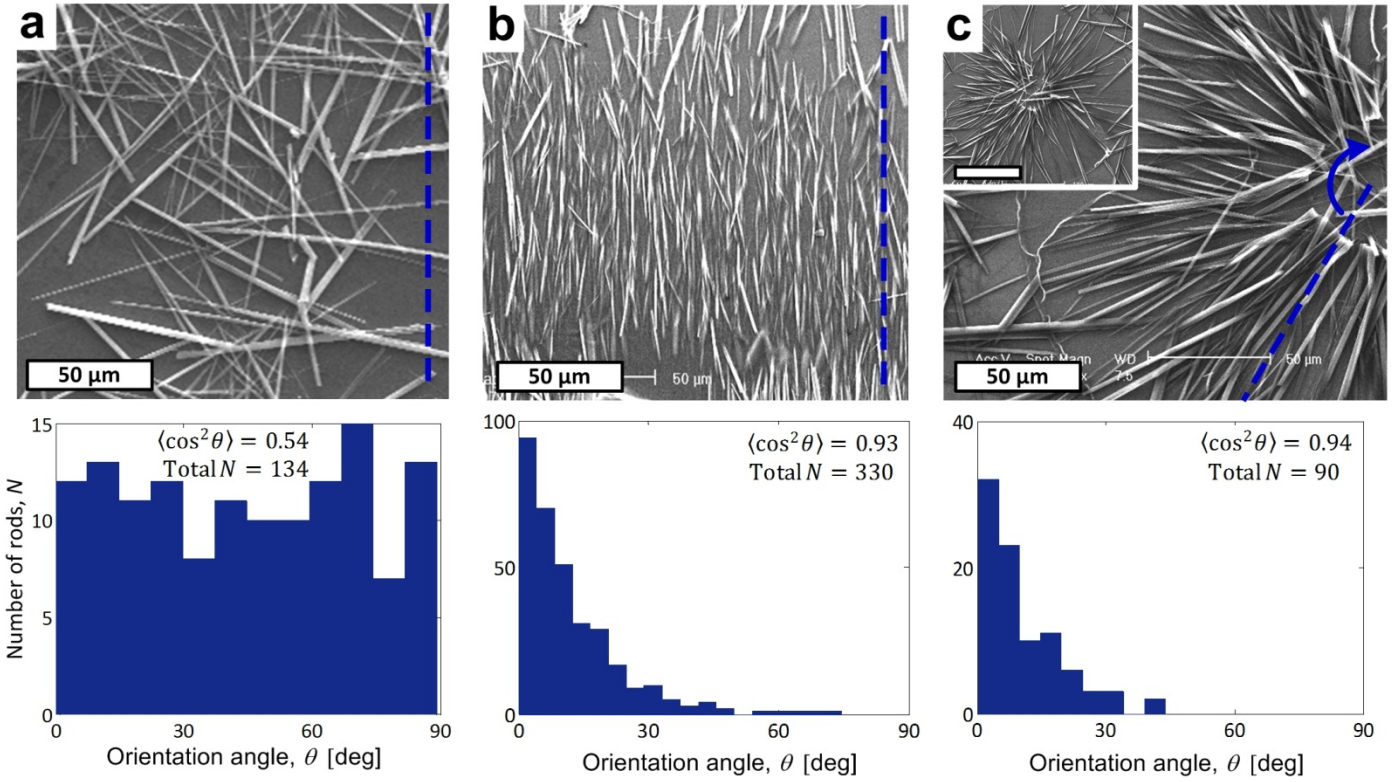
Figure 1 | Gestalt principles. (**a**) An illustration of subjective contour. (**b**) Similar objects are visually grouped. (**c**) Objects placed close to one another are seen as going together. (**d**) Relative proximity elicits vertical or horizontal correlations between objects.

Wong. *Nature Methods* 7(11):863, 2010.

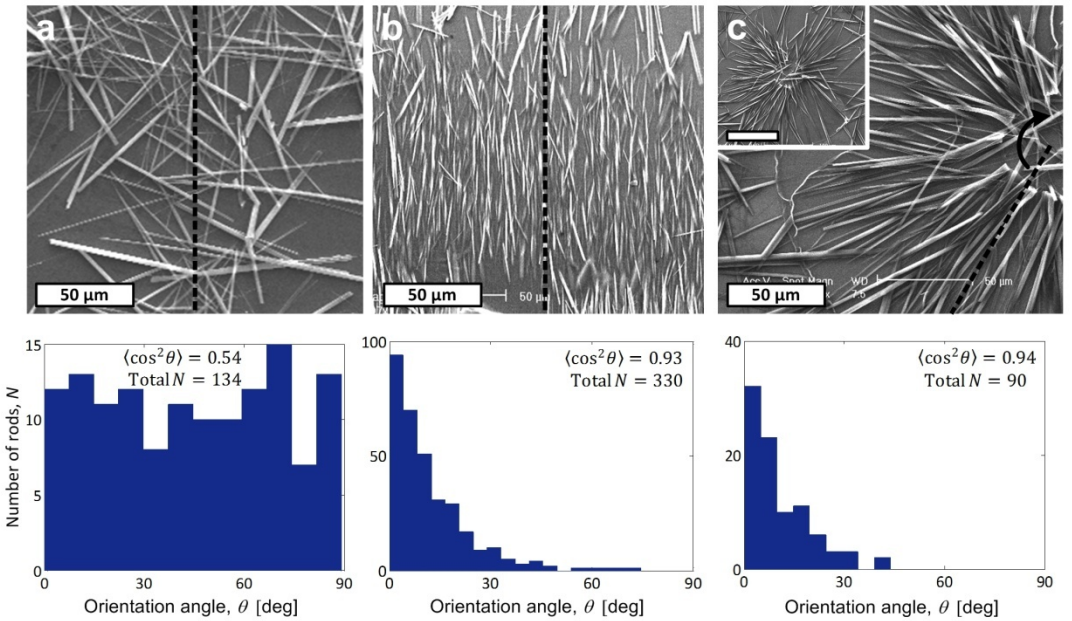

a
CNTs
C60
500 µm
CNT growth
Rolling
b
Wetting and
evaporation
CNT growth
Capillary folding
300 µm


a
50 µm
b
50 µm
50 µm
c
50 µm
50 µm
$\langle\cos^2\theta\rangle = 0.54$
Total $N = 134$
Number of rods, N
Orientation angle, θ [deg]
$\langle\cos^2\theta\rangle = 0.93$
Total $N = 330$
Orientation angle, θ [deg]
$\langle\cos^2\theta\rangle = 0.94$
Total $N = 90$
Orientation angle, θ [deg]

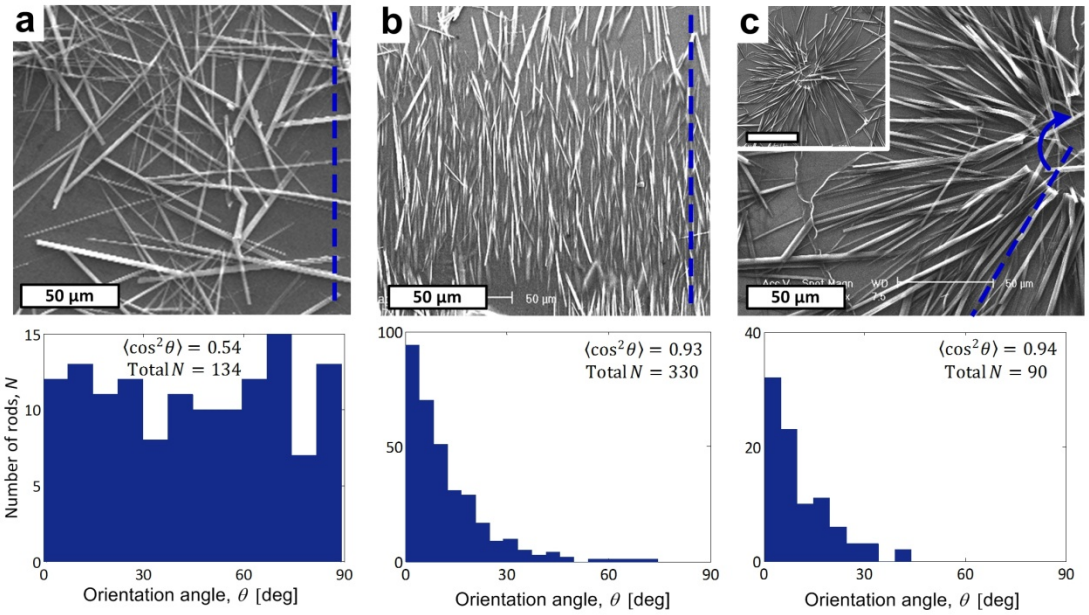

a
50 µm
b
50 µm
c
50 µm
⟨cos²θ⟩ = 0.54
Total N = 134
Number of rods, N
Orientation angle, θ [deg]
⟨cos²θ⟩ = 0.93
Total N = 330
Orientation angle, θ [deg]
⟨cos²θ⟩ = 0.94
Total N = 90
Orientation angle, θ [deg]


a
50 µm
b
50 µm
50 µm
c
50 µm
50 µm
$\langle\cos^2\theta\rangle = 0.54$
Total $N = 134$
Number of rods, N
Orientation angle, θ [deg]
$\langle\cos^2\theta\rangle = 0.93$
Total $N = 330$
Orientation angle, θ [deg]
$\langle\cos^2\theta\rangle = 0.94$
Total $N = 90$
Orientation angle, θ [deg]

original



new



Published figure (B&W)

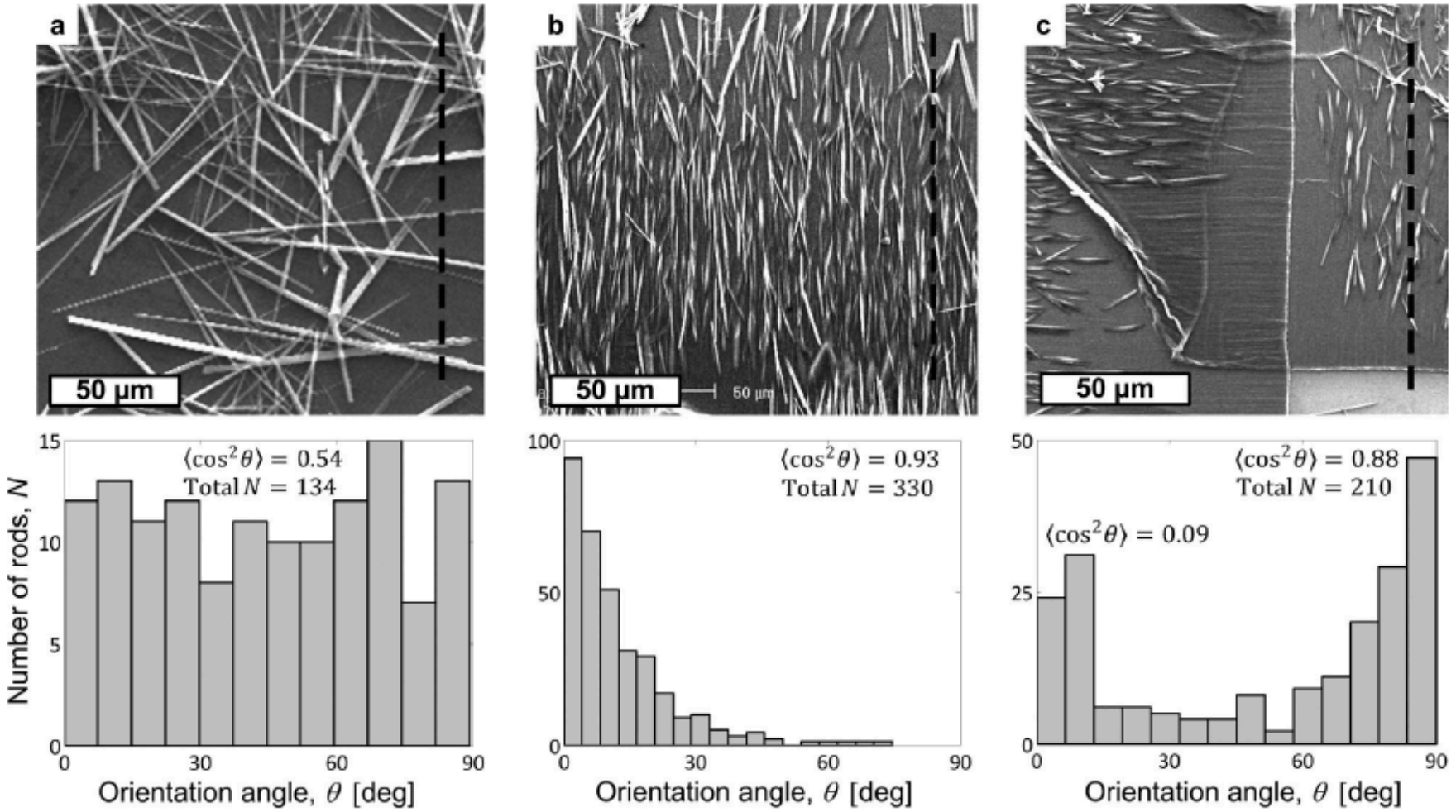


Figure 2. Scanning electron microscopy (SEM) images after synthesis of C_{60} rods on bare silicon (a), unidirectional CNT film (b), and bidirectional CNT film (c). Accompanying histograms are below each SEM, showing distribution of rod orientation relative to axis indicated by black dashed lines.

http://dx.doi.org/10.1002/adfm.201102393

Typography (text)

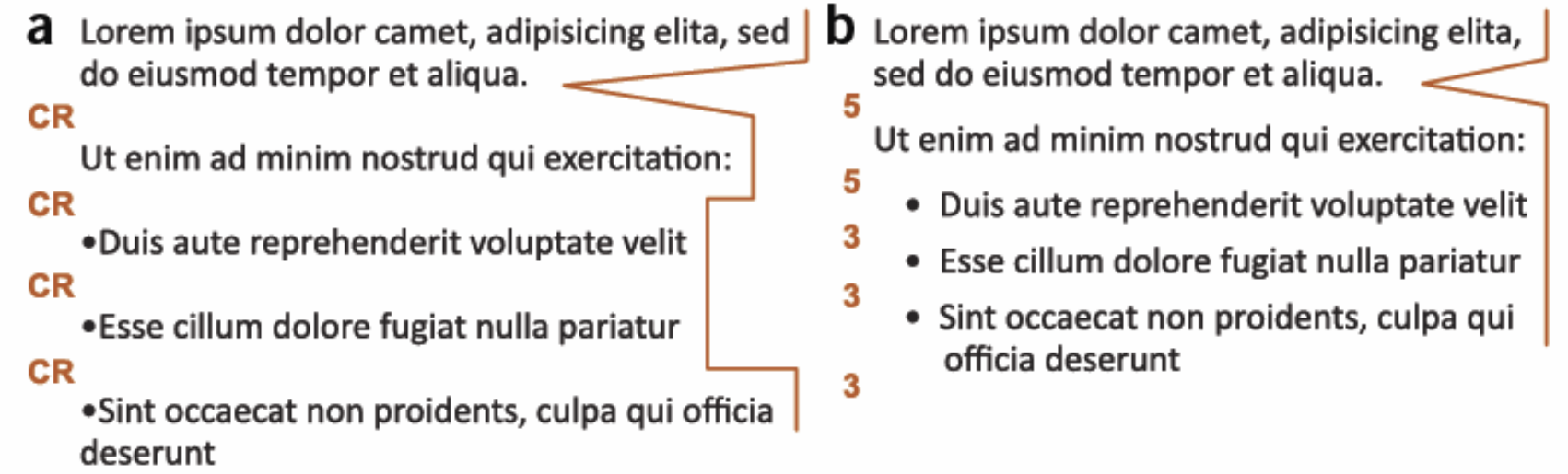
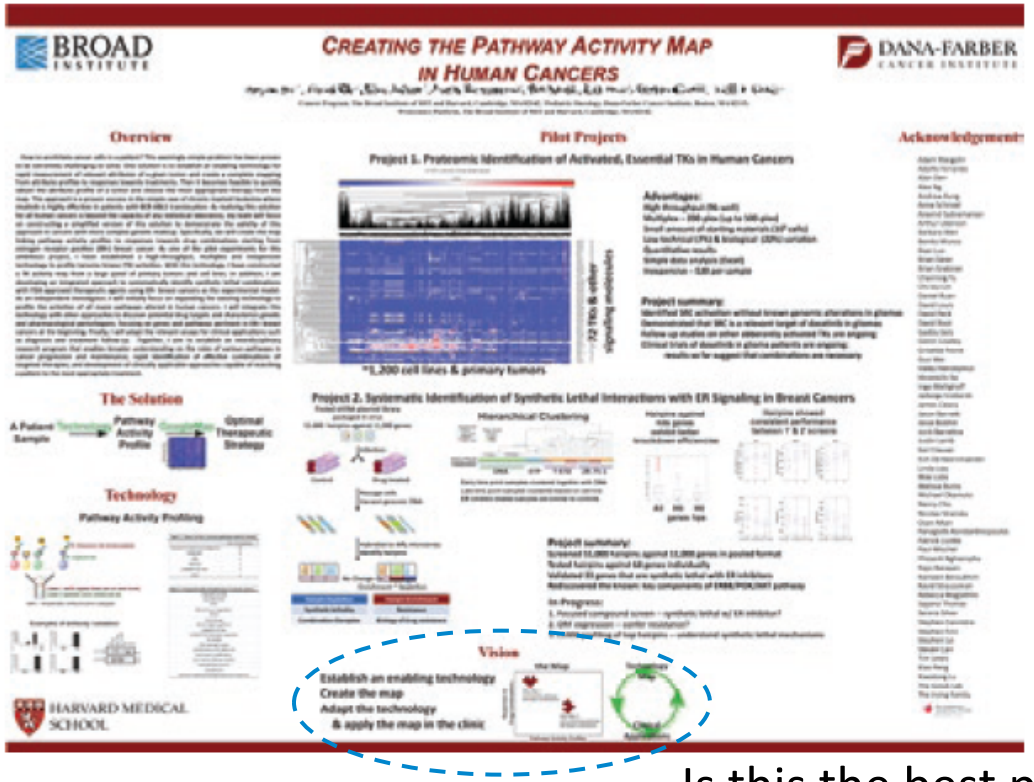


Figure 2 | Spacing can reveal structure and give meaning to text. (**a**) Uniform carriage return (CR) spacing is incongruous with hierarchical content. (**b**) Relative spacing using paragraph formatting expresses relationships in the text. Numbers are 'space after' values given in point sizes.

Wong. *Nature Methods* 8(4):277 2011.

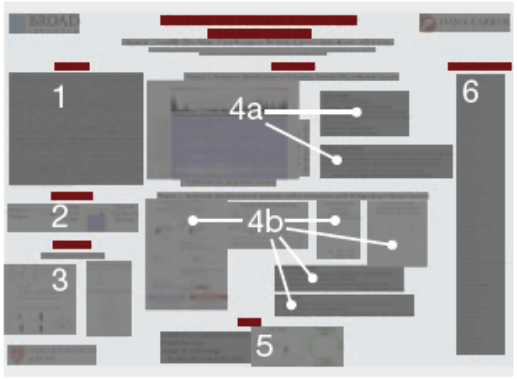
Whitespace is “the lungs of a good design”

a

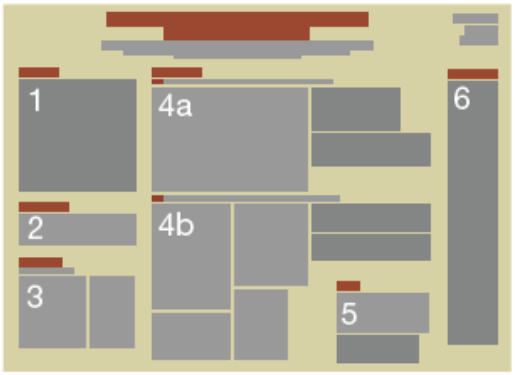


Is this the best place for the conclusion?

b

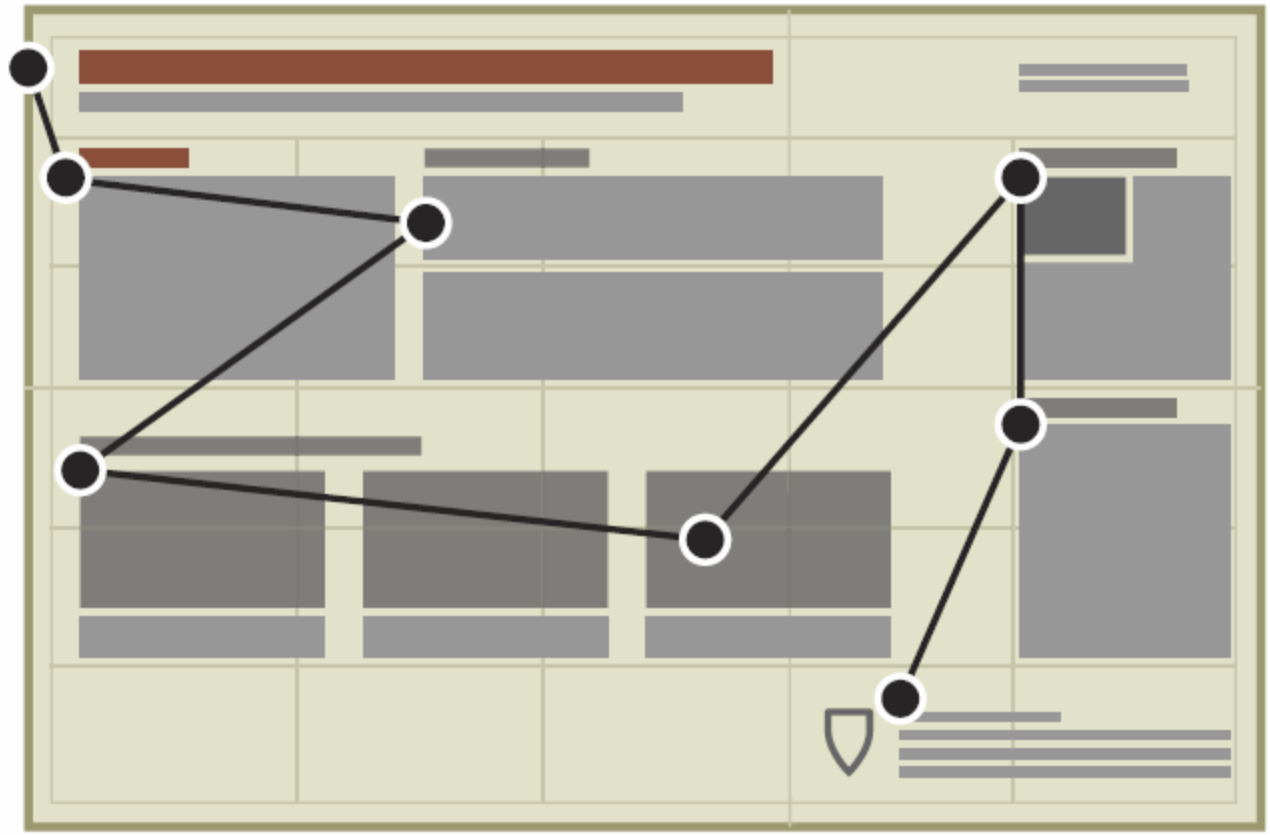


c



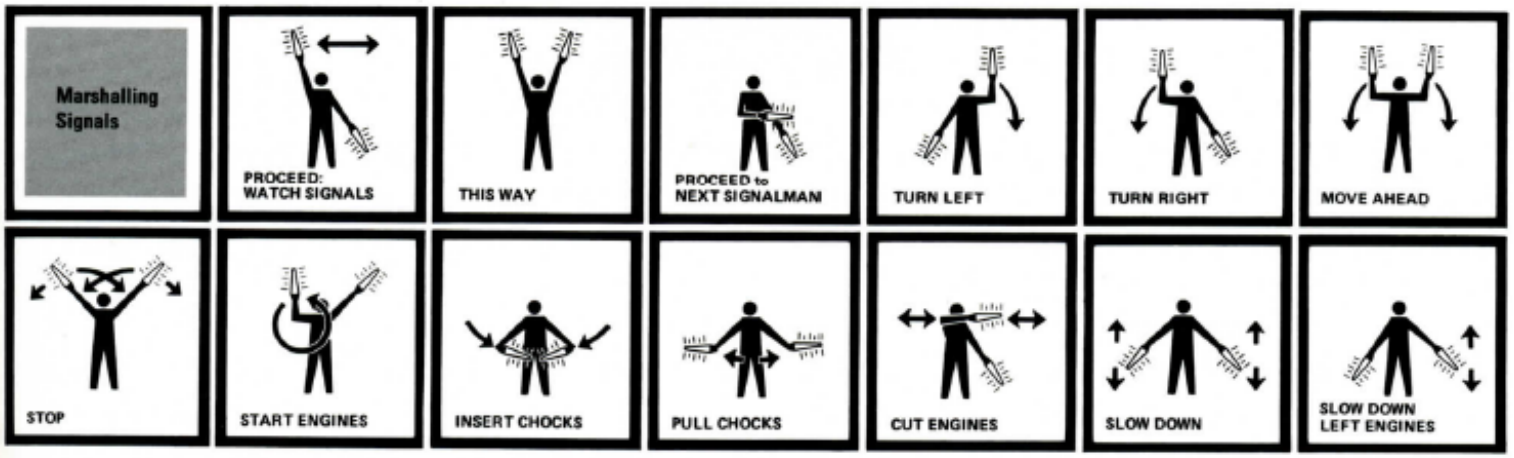
Wong. *Nature Methods* 8(1):1, 2011.

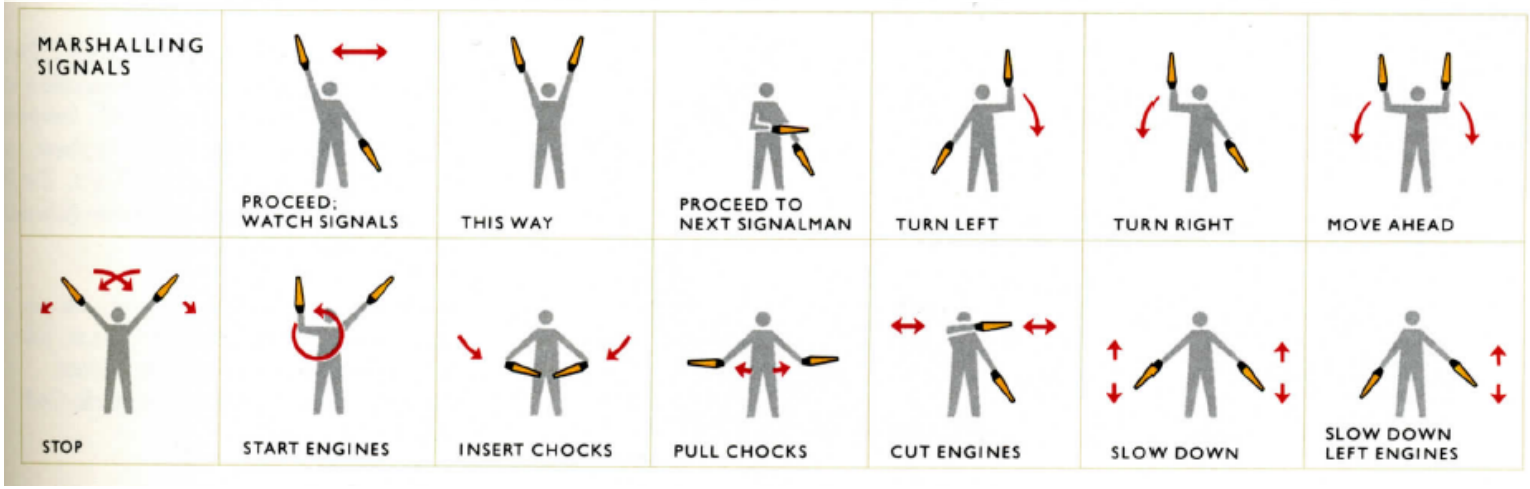
Layout: “arrange elements according to the order in which they should be read”



Wong. *Nature Methods* 8(10):783, 2011.

Putting it all together in an “infographic”

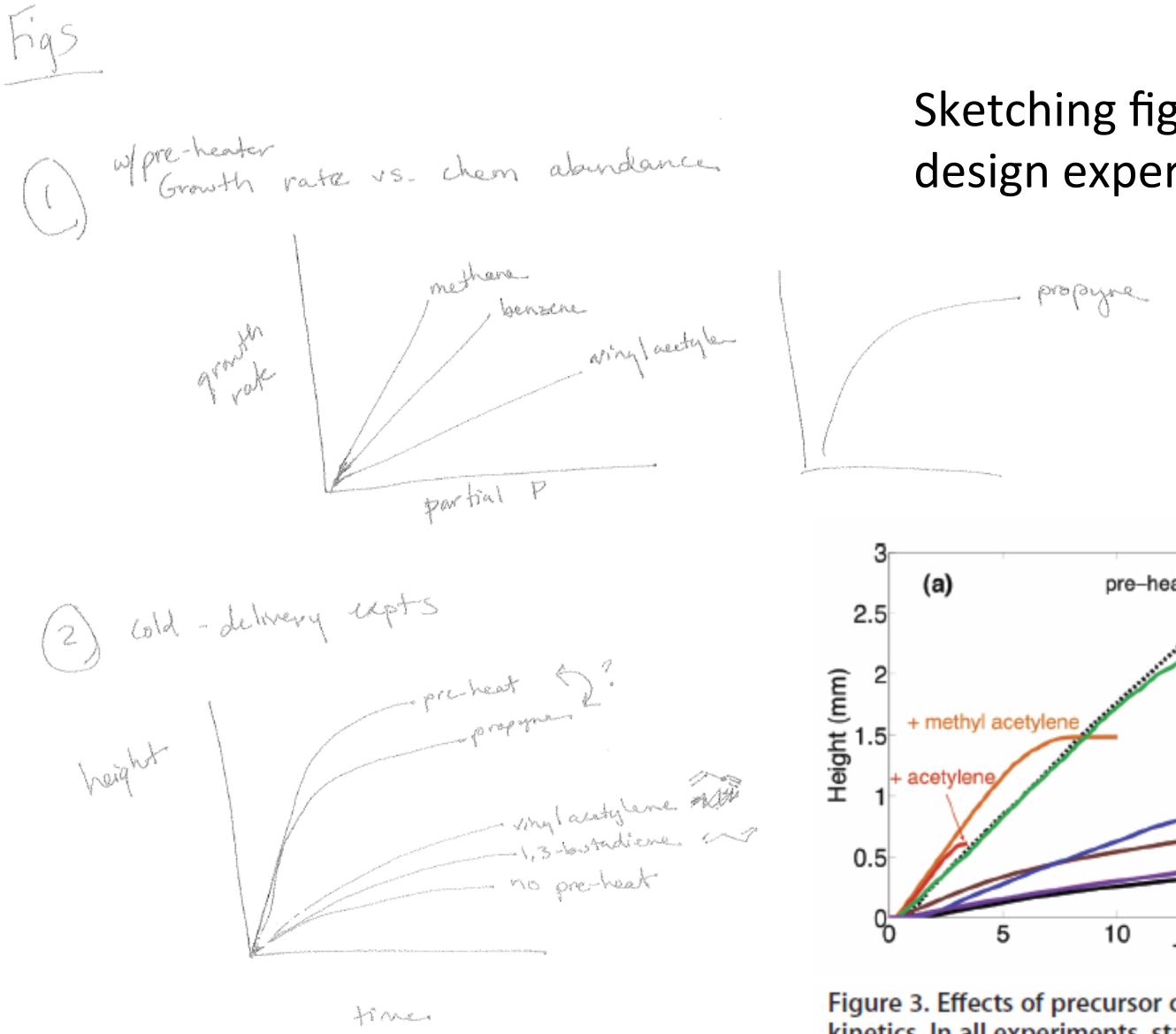




- Avoid competition between visual elements
- Remove unnecessary annotation
- Use color to make important points

Tufte, Envisioning Information.

How to start? Maybe sketch.



Sketching figures can also help design experiments!

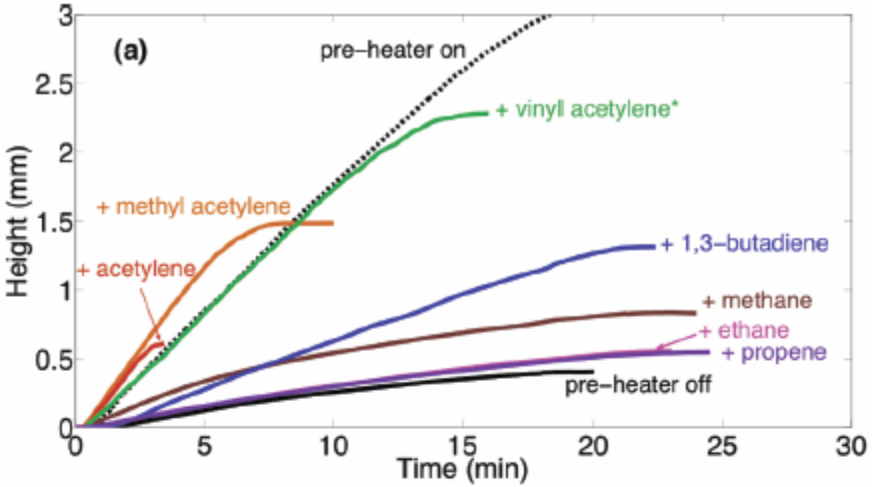
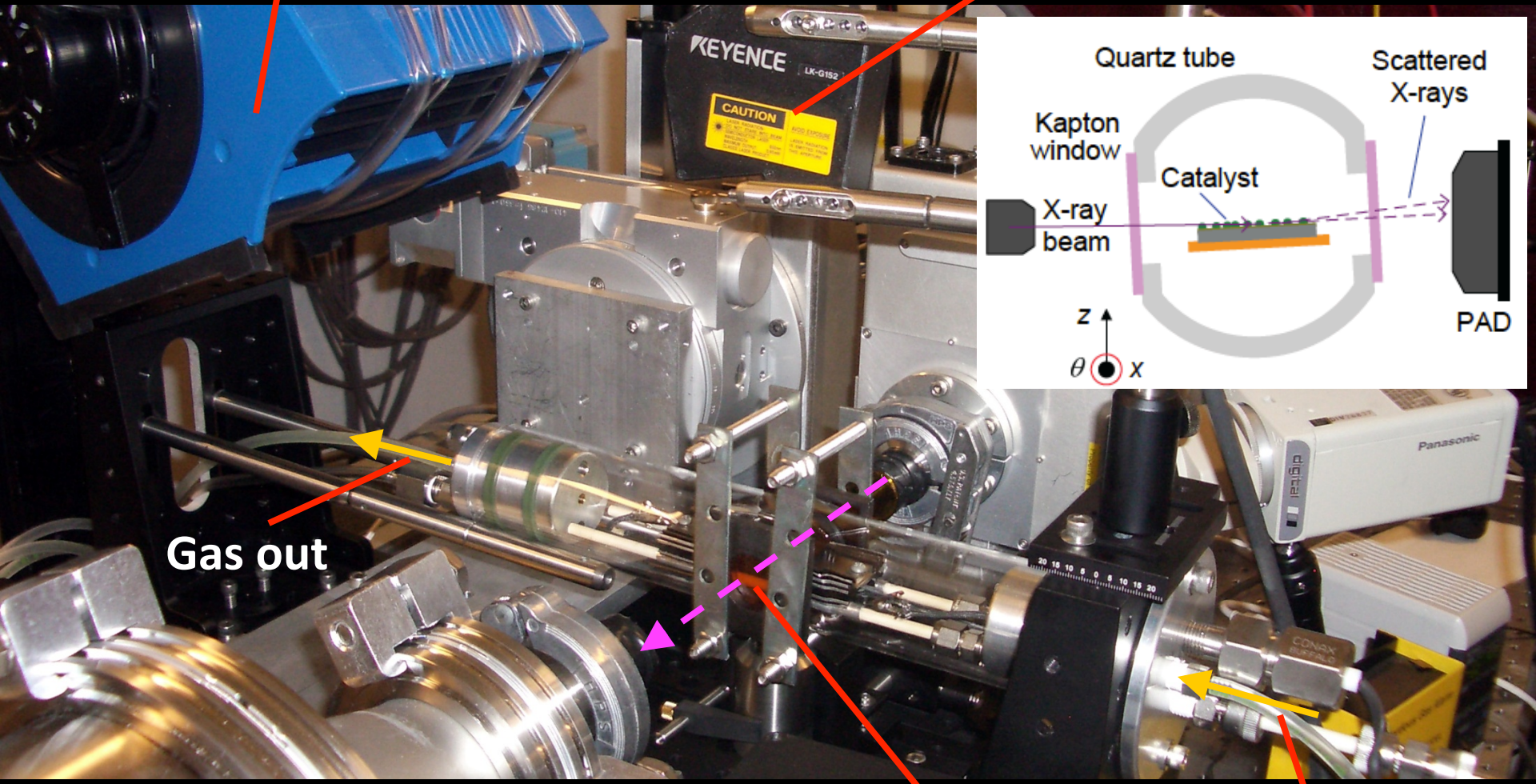


Figure 3. Effects of precursor chemical structure on CNT growth kinetics. In all experiments, standard growth gases (C_2H_4/H_2 = 120/310 sccm) were delivered without preheating in addition to

Images: annotations and visual cues



Showing practical scales

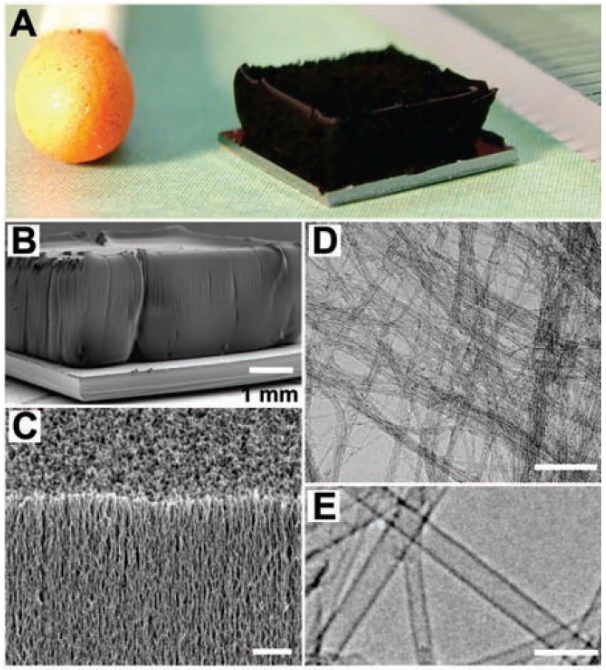
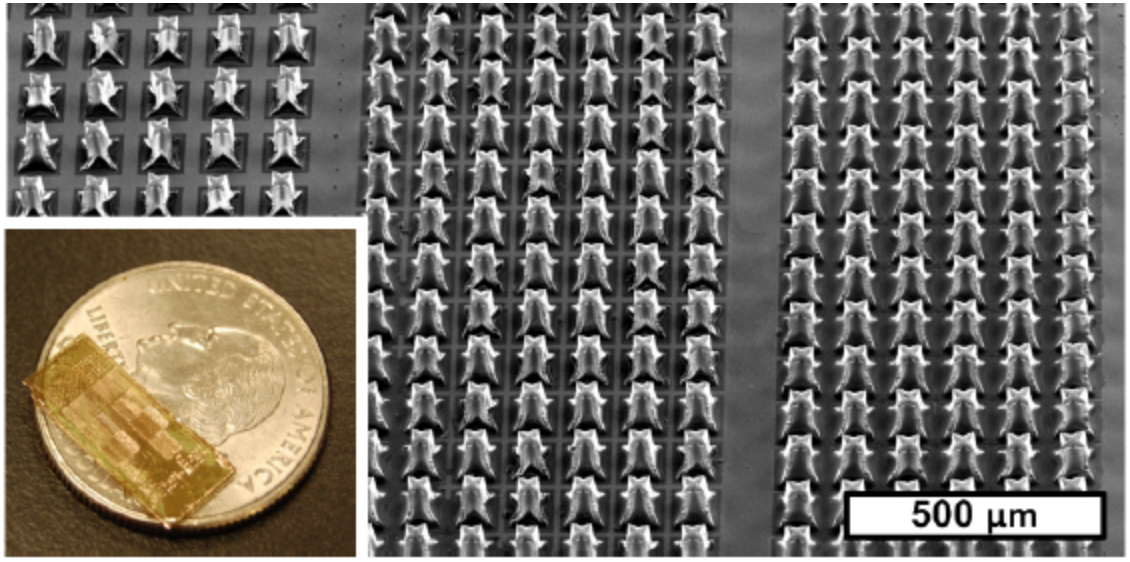


Fig. 1. SWNT forest grown with water-assisted CVD. (**A**) Picture of a 2.5-mm-tall SWNT forest on a 7-mm by 7-mm silicon wafer. A matchstick on the left and ruler with millimeter markings on the right is for size reference. (**B**) Scanning electron microscopy (SEM) image of the same SWNT forest. Scale bar, 1 mm. (**C**) SEM image of the SWNT forest ledge. Scale bar, 1 μm. (**D**) Low-resolution TEM image of the nanotubes. Scale bar, 100 nm. (**E**) High-resolution TEM image of the SWNTs. Scale bar, 5 nm.

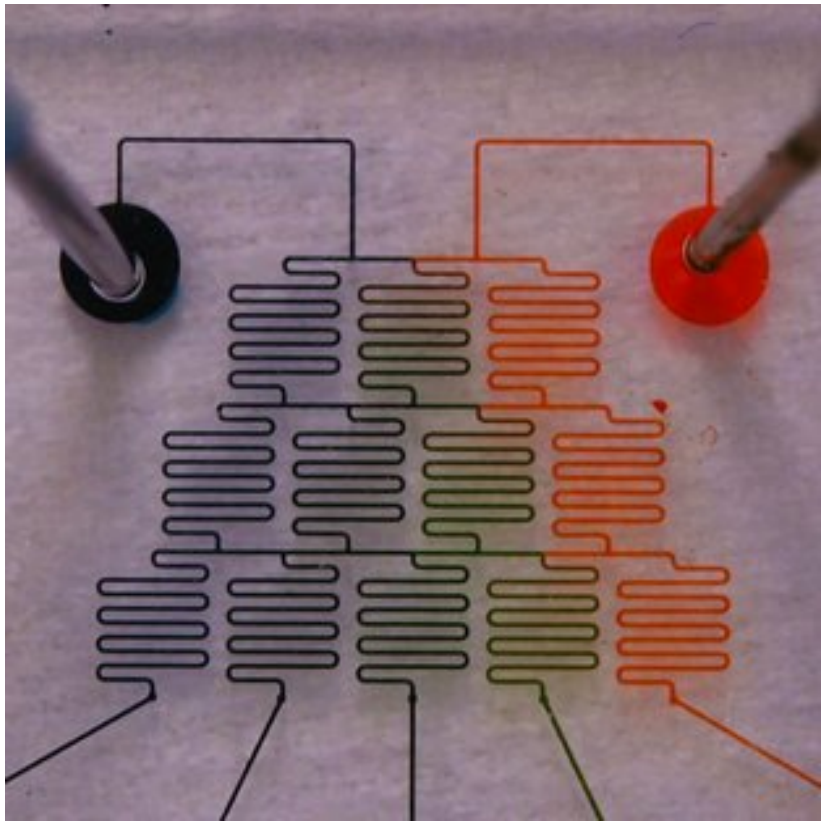
Hata et al.



Copic et al.

Showing scale and function

Showing function with color

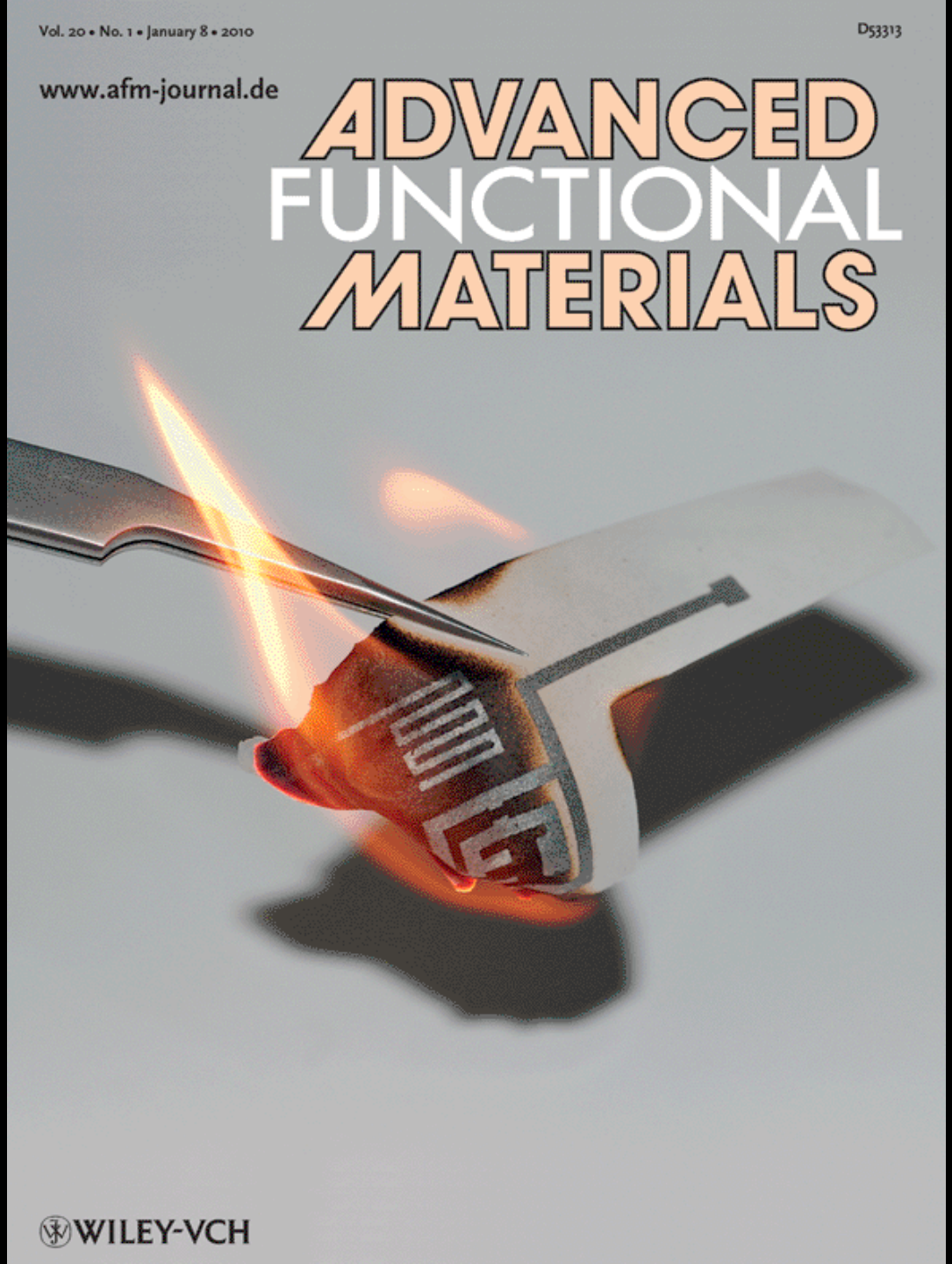


Using microfluidic devices and a substrate annealing gradient system large arrays of organic thin-film transistors (OTFTs) are fabricated from poly(didodecylquaterthiophene-*alt*-didodecylbithiazole).

http://onlinelibrary.wiley.com/doi/10.1002/adma.201003815/abstract

Lightweight and flexible printed circuit boards (PCBs) have been produced by micro-patterning metal on paper substrates, as reported by Siegel et al. on page 28. Paper-based electronic devices can be folded and creased repeatedly, shaped to form three-dimensional structures, integrated with paper-based microfluidic devices, and disposed of by flame (as shown in the cover image).

http://onlinelibrary.wiley.com/doi/10.1002/adfm.200990114/abstract



The ToC figure (= a visual abstract, a carrot)

Population Growth Dynamics of Carbon Nanotubes

Mostafa Bedewy, Eric R. Meshot, Michael J. Reinker, and A. John Hart*
Mechanosynthesis Group, Department of Mechanical Engineering, University of Michigan, 2350 Hayward Street, Ann Arbor, Michigan 48109, United States

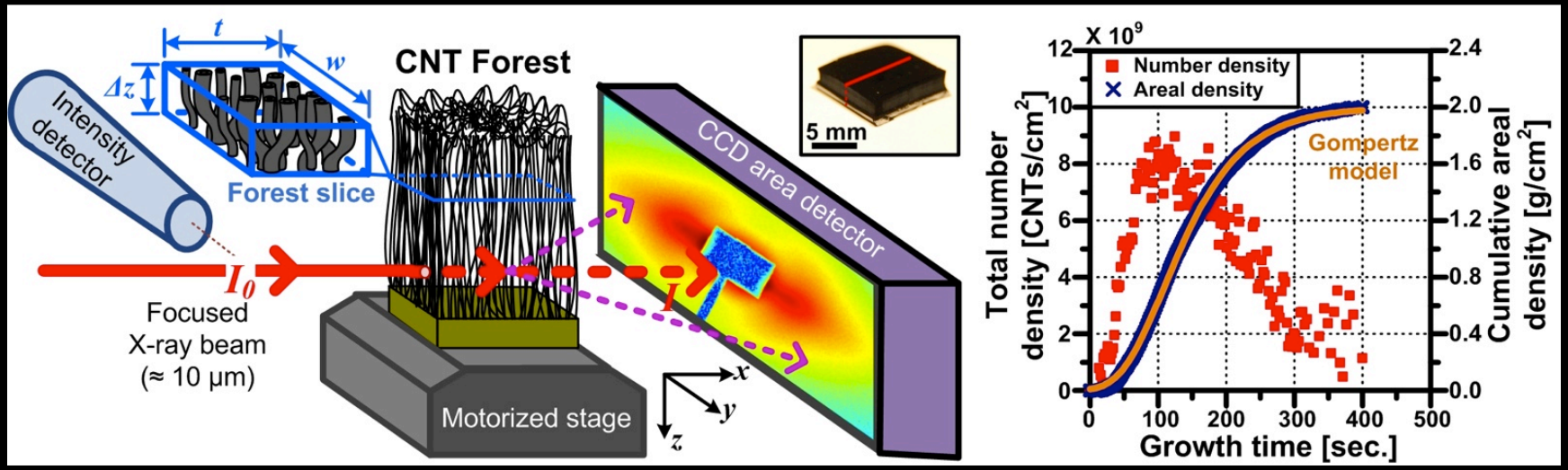
ACS Nano, **2011**, 5 (11), pp 8974-8989
DOI: 10.1021/nn203144f
Publication Date (Web): October 23, 2011

Get It

Address correspondence to ajohnh@umich.edu.

Section: Surface Chemistry and Colloids

Abstract | Supporting Info
Full Text HTML | Figures
Hi-Res PDF [6772 KB] | Citing Articles
PDF w/ Links [1542 KB]



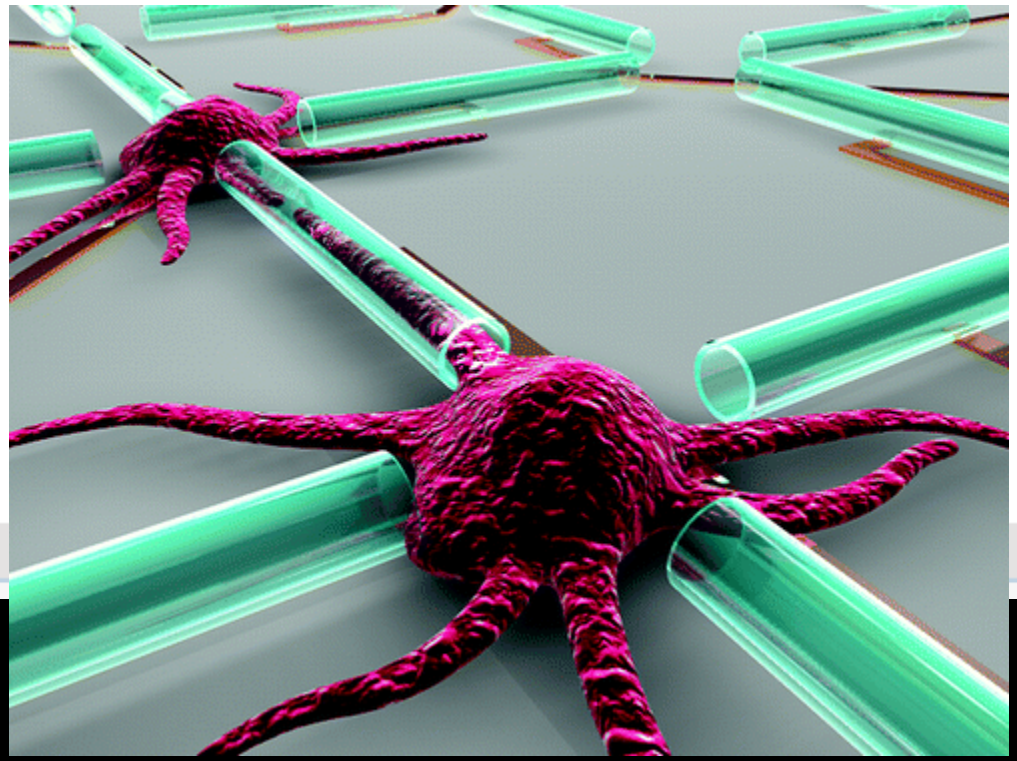
Understanding the population growth behavior of filamentary nanostructures, such as carbon nanotubes (CNTs), is hampered by the lack of characterization techniques capable of probing statistical variations with high spatial resolution. We present a comprehensive methodology for studying the population growth dynamics of vertically aligned CNT forests, utilizing high-resolution spatial mapping of synchrotron X-ray scattering and attenuation, along with real-time height kinetics. We map the CNT alignment and dimensions within CNT forests, revealing broadening and focusing of size distributions during different stages of the process. Then, we calculate the number density and mass density of the CNT population *versus* time, which are true measures of the reaction kinetics. We find that the mass-based kinetics of a CNT population is accurately represented by the S-shaped Gompertz model of population growth, although the forest height and CNT length kinetics are essentially linear. Competition between catalyst activation and deactivation govern the rapid initial acceleration and slow decay of the CNT number density. The maximum CNT density (*i.e.*, the overall catalyst activity) is limited by gas-phase reactions and catalyst-surface interactions, which collectively exhibit autocatalytic behavior. Thus, we propose a comprehensive picture of CNT population growth which combines both chemical and mechanical cooperation. Our findings are relevant to both bulk and substrate-based CNT synthesis methods and provide general insights into the self-assembly and collective growth of filamentary nanostructures.

Keywords: carbon nanotubes; kinetics; filaments; X-ray; characterization; population; chemical vapor deposition; catalyst

Semiconductor Nanomembrane Tubes: Three-Dimensional Confinement for Controlled Neurite Outgrowth

Minrui Yu, Yu Huang, Jason Ballweg, Hyuncheol Shin, Minghuang Huang, Donald E. Savage, Max G. Lagally, Erik W. Dent, Robert H. Blick, and Justin C. Williams

Publication Date (Web): March 2, 2011 (Article)



http://pubs.acs.org/doi/abs/10.1021/nn103618d

Article

Prev. | Next | Table of Contents

Rare Sandwich-Type Polyoxomolybdates Constructed from Di-/Tetra-Nuclear Transition-Metal Clusters and Trivacant Keggin Germanomolybdate Fragments

Suzhi Li, Junwei Zhao, Pengtao Ma, Juan Du, Jingyang Niu* and Jingping Wang*
Institute of Molecular and Cr
of Chemistry and Chemical E
University, Kaifeng, Henan

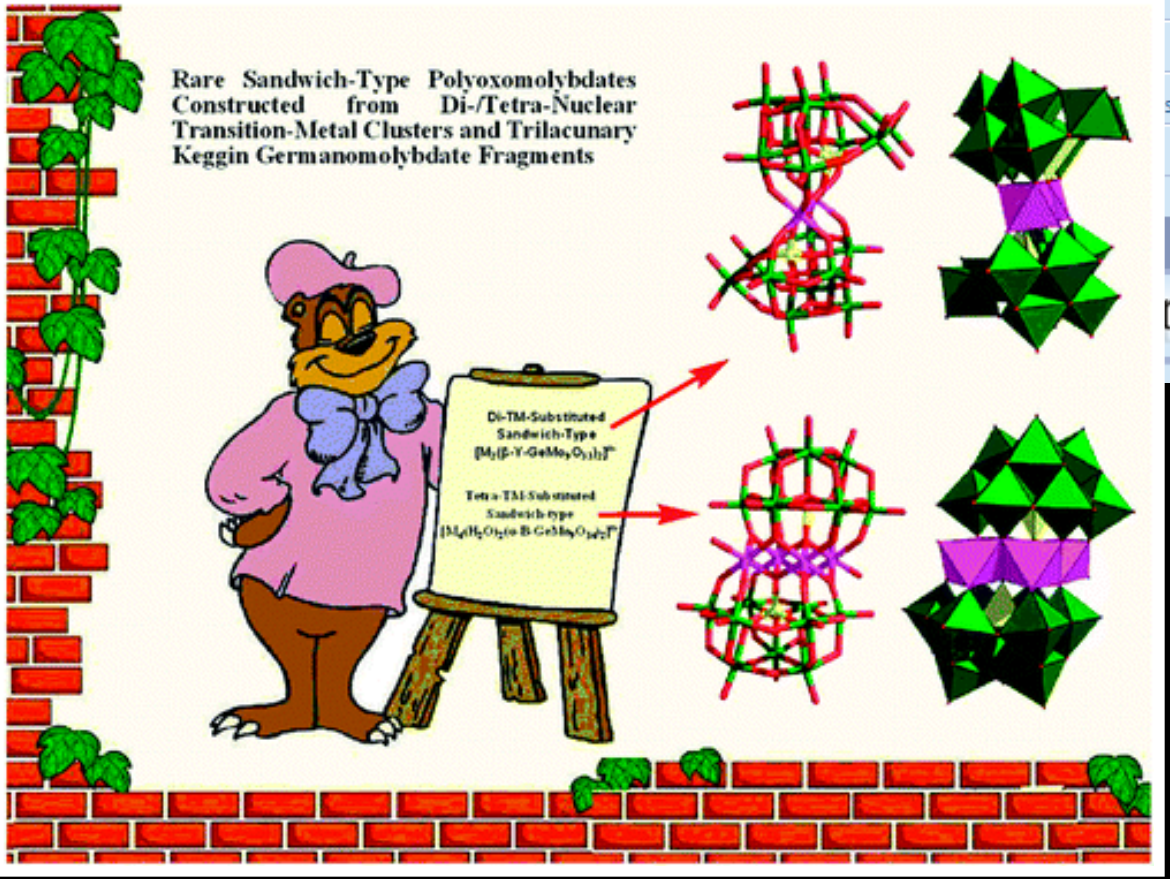
Inorg. Chem., 2009, *48* (20), p
DOI: 10.1021/ic901330y
Publication Date (Web): Septe

MGet It

*To whom correspondence sh
(J.W.). Fax: (+86) 378 3886876.

Abstract | Supporting Info

Tools
Add to Favorites
Download Citation
Email a Colleague



http://pubs.acs.org/doi/abs/10.1021/ic901330y

Sun-Believable Solar Paint. A Transformative One-Step Approach for Designing Nanocrystalline Sola

Matthew P. Genovese,† Ian V. Lightcap, and Prashant V. Kamat*

Radiation Laboratory and Department of Chemistry and Biochemistry, University of Notre Dame, Notre Dame, Indiana 4655
University of Waterloo, Canada.

ABSTRACT

A transformative approach is required to meet the de
technology. By making use of recent advances in semico
now developed a one-coat solar paint for designing
paste consisting of CdS, CdSe, and TiO_2 semiconductor
to conducting glass surface and annealed at 473 K. T
semiconductor film electrodes was evaluated in a p
graphene–Cu_2S counter electrode and sulfide/polysul
as high as 600 mV and short circuit current of 3.1 mA/c
TiO_2 electrodes. A power conversion efficiency exceedi
constructed using the simple conventional paint brus
Whereas further improvements are necessary to deve
state devices, this initial effort to prepare solar paint
and economically viable next generation solar cells.

KEYWORDS: solar cells · photoconversion · sola
nanocrystals · photoelectrochemistry · metal cha

What if all it takes is a coat of paint to convert light energy into electricity? That is the challenge that needs to be addressed if we desire to have a transformative photovoltaic technology and meet future energy needs.[1,2] In recent years semiconductor nanocrystal or quantum-dot-based solar cells have drawn significant attention as viable candidates for boosting the energy conversion efficiency beyond the traditional Shockley and Queisser limit of 32% for Si-based solar cells.[3–12]

Because of the extremely small size of semiconductor quantum dots and high absorption cross section, it is possible to capture nearly all of the incident solar light in the visible region with an extremely thin layer of semiconductor materials. These heterojunction semiconductor solar cells, often referred as ETA (extremely thin absorber) cells, offer new opportunities to develop relatively inexpensive solar cells.[13,14] One such example utilizes a PbS and TiO_2 heterojunction and is reported to exhibit a power conversion efficiency of 5.1%.[15] Similarly, Sb_2S_3-based ETA solar cells have delivered efficiencies greater than 5%.[13,16,17] These recent developments of photoinduced charge separation using semiconductor nanocrystal-based assemblies and efforts to utilize them in solar cells paves the way to propose transformative research efforts.

The other type of quantum dot solar cell employs metal chalcogenide semiconductors as sensitizers which, upon excitation, inject electrons into large band gap semiconductors such as TiO_2. The sulfide/polysulfide redox couple, which scavenges holes from the photoanode, is regenerated at the counter electrode. The photoelectrochemical cells employing CdS and CdSe have been widely studied, and power conversion efficiency in the 3–4% range is often achieved.[14–16,18–22] A recent study that overcomes the redox limitation at the counter electrode by using Cu_2S/reduced graphene oxide has produced efficiency as high as 4.4%.[22] Previous work in our laboratory has provided understanding of the photoinduced charge transfer processes in semiconductor quantum dots and their utilization in semiconductor-sensitized solar cells (Scheme 1).[23–25]

Published online December 06, 2011
10.1021/nn204881g

Figures in proposals

- To sell the main idea
- To summarize the background
- To show preliminary results
- To show your proposed methods/experiments
- To explain how the key pieces fit together
  - Team
  - Tasks
  - Time

The main idea in words

Project Summary

Research Objectives: This research will seek to enable a manufacturing technology for continuous large-scale production of aligned carbon nanotube (CNT) films by chemical vapor deposition (CVD), and for integration of these films in new hybrid material architectures including structural composites. Phase one will undertake a fundamental study of CNT forest nucleation and growth from a film of metal catalyst nanoparticles on a substrate. Limiting mechanisms of catalyst activation and lifetime will be determined by conducting repeated CNT growth, film delamination, catalyst treatment, and microscopy and surface analysis experiments on centimeter-scale substrates. We will utilize our novel heated platform reactor with *in situ* monitoring of the growth kinetics and CNT quality for these tests. In phase two, a meter-scale benchtop "ring" growth apparatus will be designed and built, facilitating rapid growth of CNT films on a continuously recirculating substrate. A comprehensive set of preliminary studies in CNT growth and characterization, the interdisciplinary expertise of the research team, and strong industrial interest and support, prepares us for focused progress toward the program objectives within the proposed timeline.

CNT forests will be incorporated in a "nanostitched" hybrid composite architecture, which is being developed with broad aerospace industry support through MIT's Nano-Engineered Composite Structures (NECST) Consortium. NECST was been formed as a collaboration among the PI and co-PIs during the PI's postdoctoral work at MIT. The mechanical (e.g., toughness, strength), thermal, and electrical properties of these larger-scale structures will be evaluated using standard tests, and will be related to the characteristics of the embedded CNT layers and the reaction parameters.

The main idea in pictures

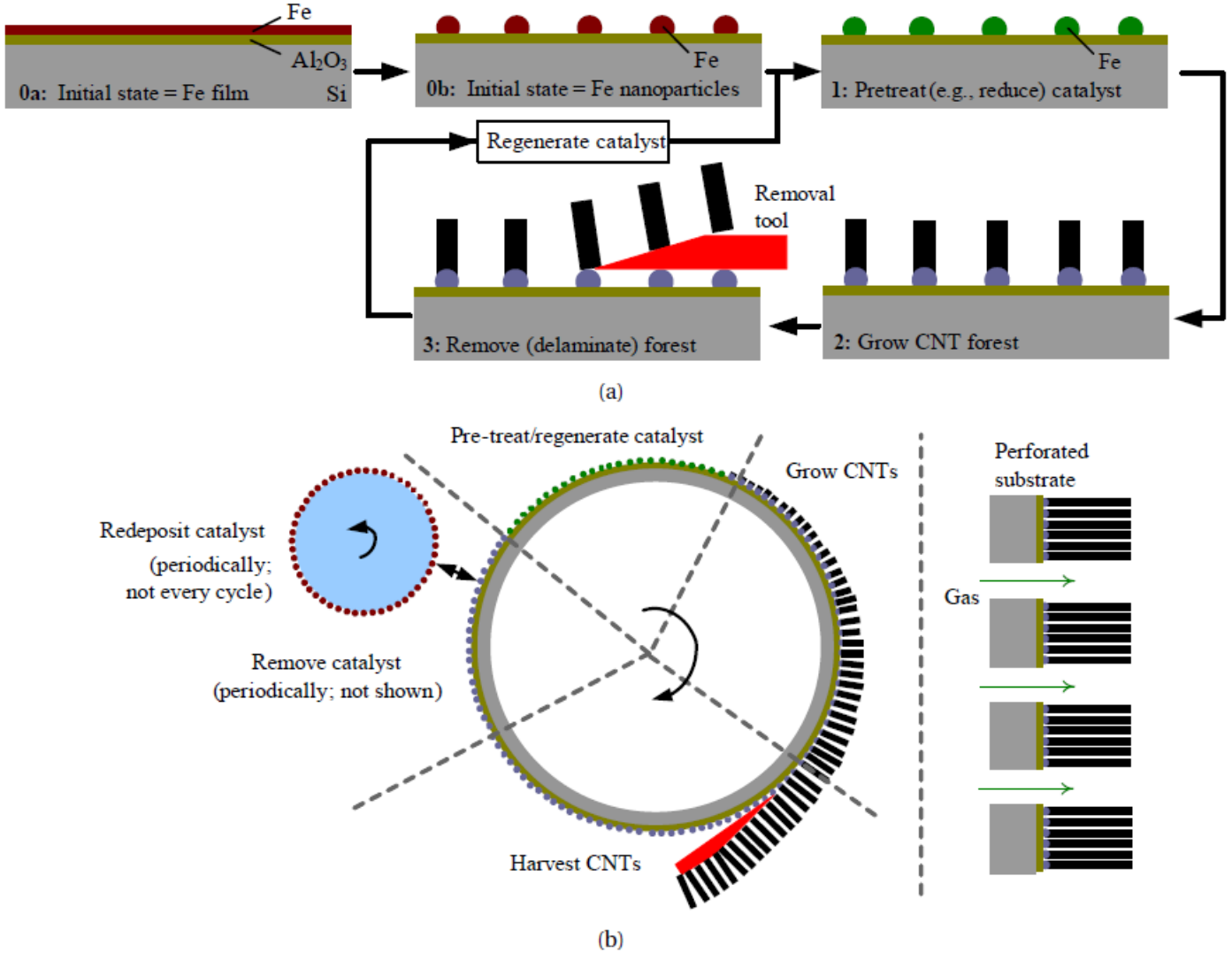


Figure 1. Proposed investigation of continuous manufacturing of CNT films: (a) schematic of batch-style study of consecutive catalyst treatment, CNT growth, CNT removal, and catalyst regeneration experiments; (b) schematic of ring apparatus with recirculating substrate, and perforated substrate concept.

Summarizing background literature

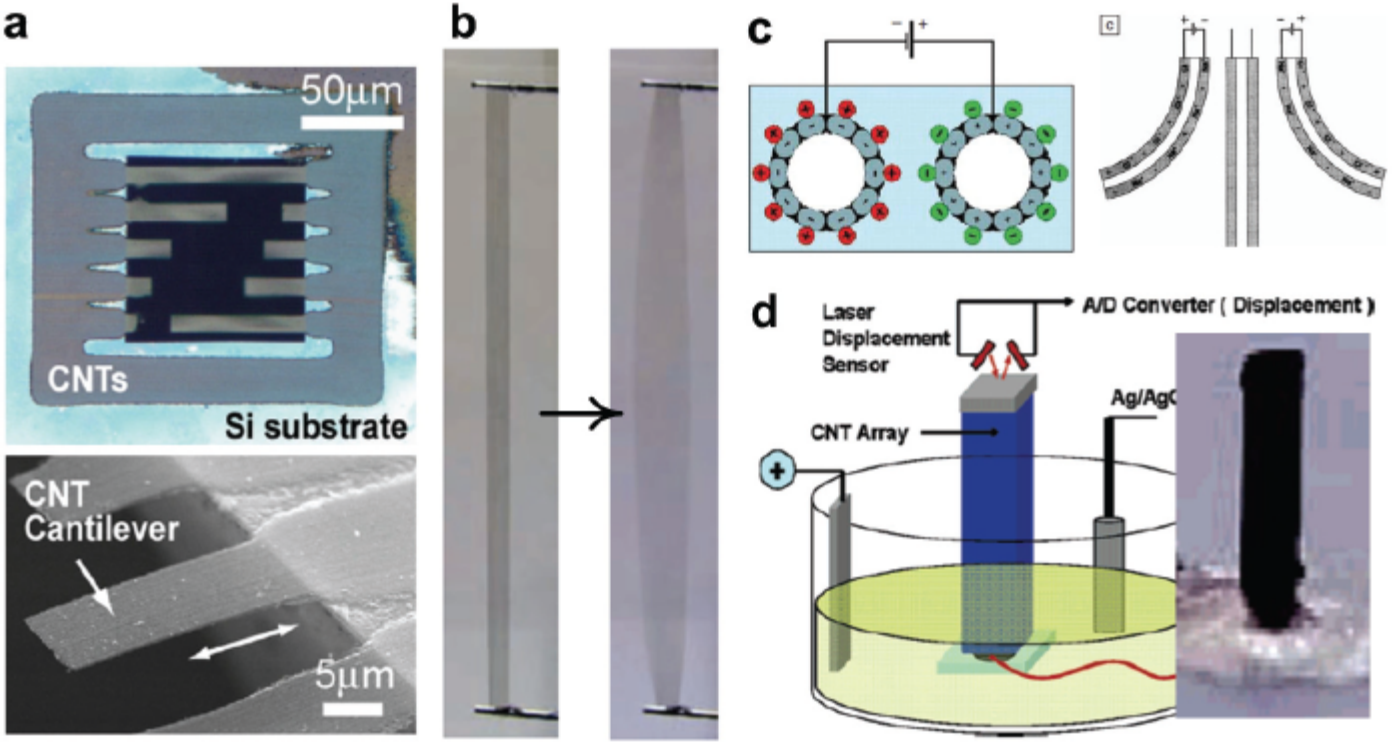
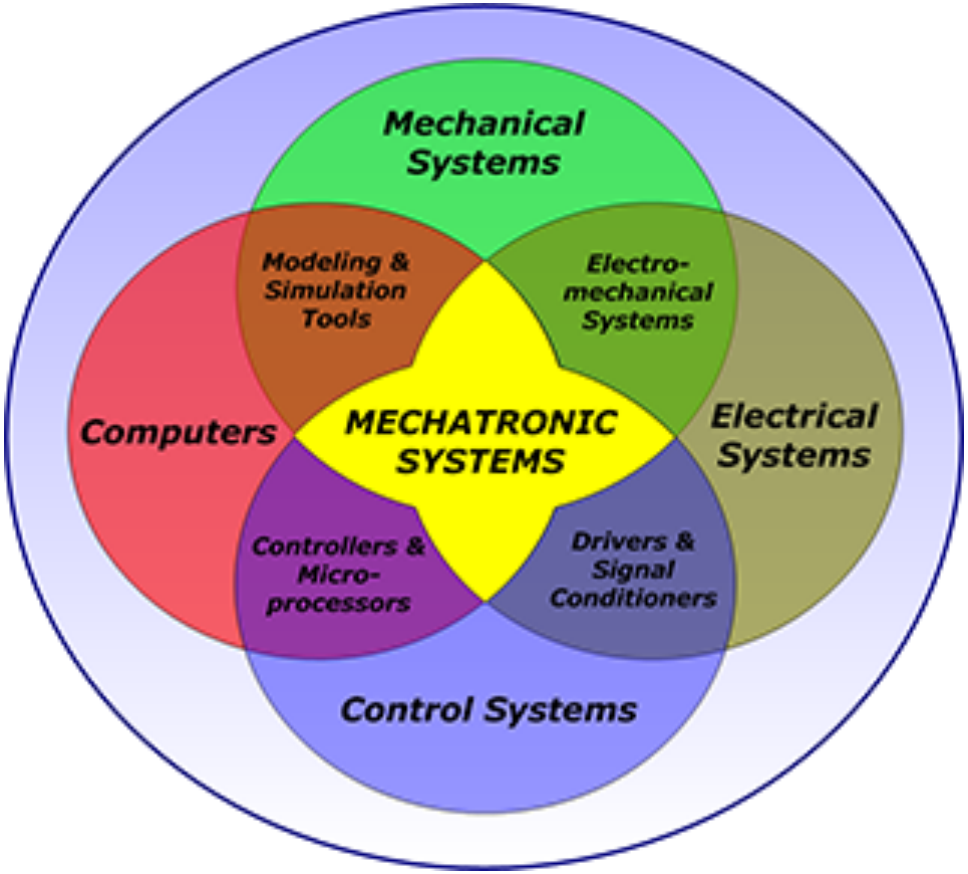


Fig. 3. Selected previous work on CNT-based actuators and active materials: (a) electrostatic deflection of a suspended CNT thin-film (ref. Hayamizu); CNT sheet "aerogel muscles" (ref. Aliev); (c) mechanism of bending CNT sheets by electrochemical actuation (ref. Baughman); (d) lengthening of a vertically-aligned CNT tower immersed in a salt bath (ref. Yun)

How different concepts fit together

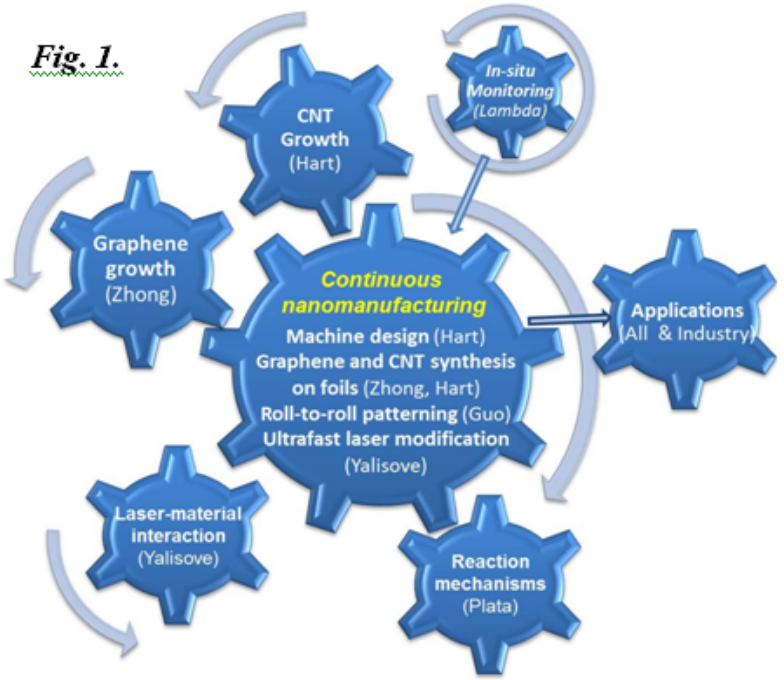


How a team fits together

1. The Vision

This proposal aims to invent and develop new high-throughput scalable nanomanufacturing (SNM) technologies that will bring graphene and nanotube (CNT) based materials and their hybrids to practical large area applications in electronics, optoelectronics, and mechanics. The breadth of these applications and the requirement to integrate them into continuous manufacturing demand a multidisciplinary approach, supported by a fundamental understanding of the underlying mechanisms (Fig. 1). These fundamentals will drive principles and design methods for machines and processes that manufacture nanoscale structures, devices, and systems using carbon nanomaterials. The project will build a lab-scale machine for continuous CVD of CNTs and graphene on flexible substrates, and integrate a suite of novel and scalable patterning and modification techniques with large-area films made by the continuous CVD process. Together, the SNM technology will be used to build and test CNT- and graphene-based hybrid photovoltaics, broadband cloaks, and high-surface-area filters. The research will be complimented with a strong educational component and outreach activities, and collaboration with industry.

Fig. 1.



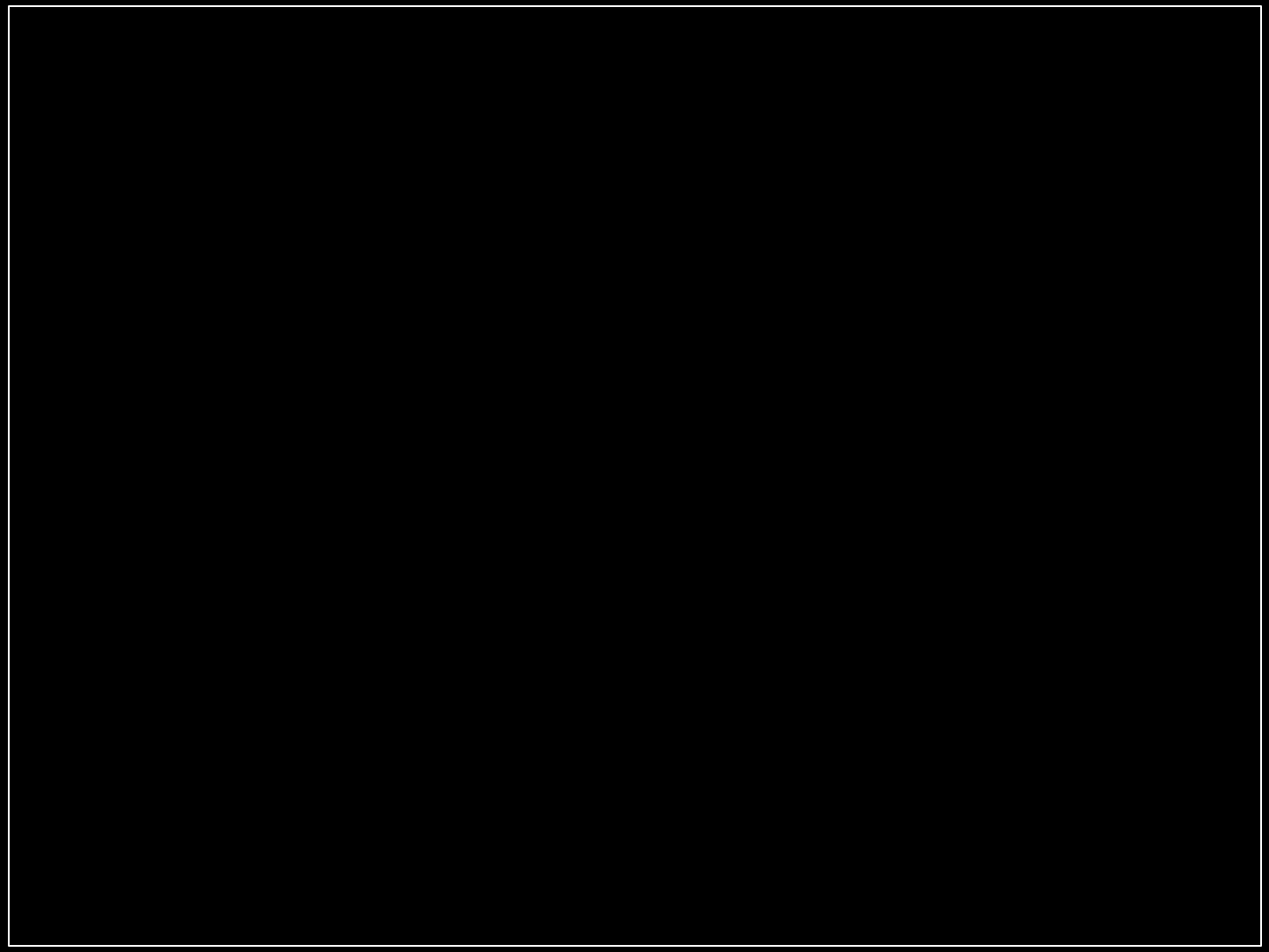
2. The Team

This SNM program brings together an interdisciplinary team of recognized experts in the area of nanofabrication and high throughput nanomanufacturing, CNT and graphene materials and devices, and

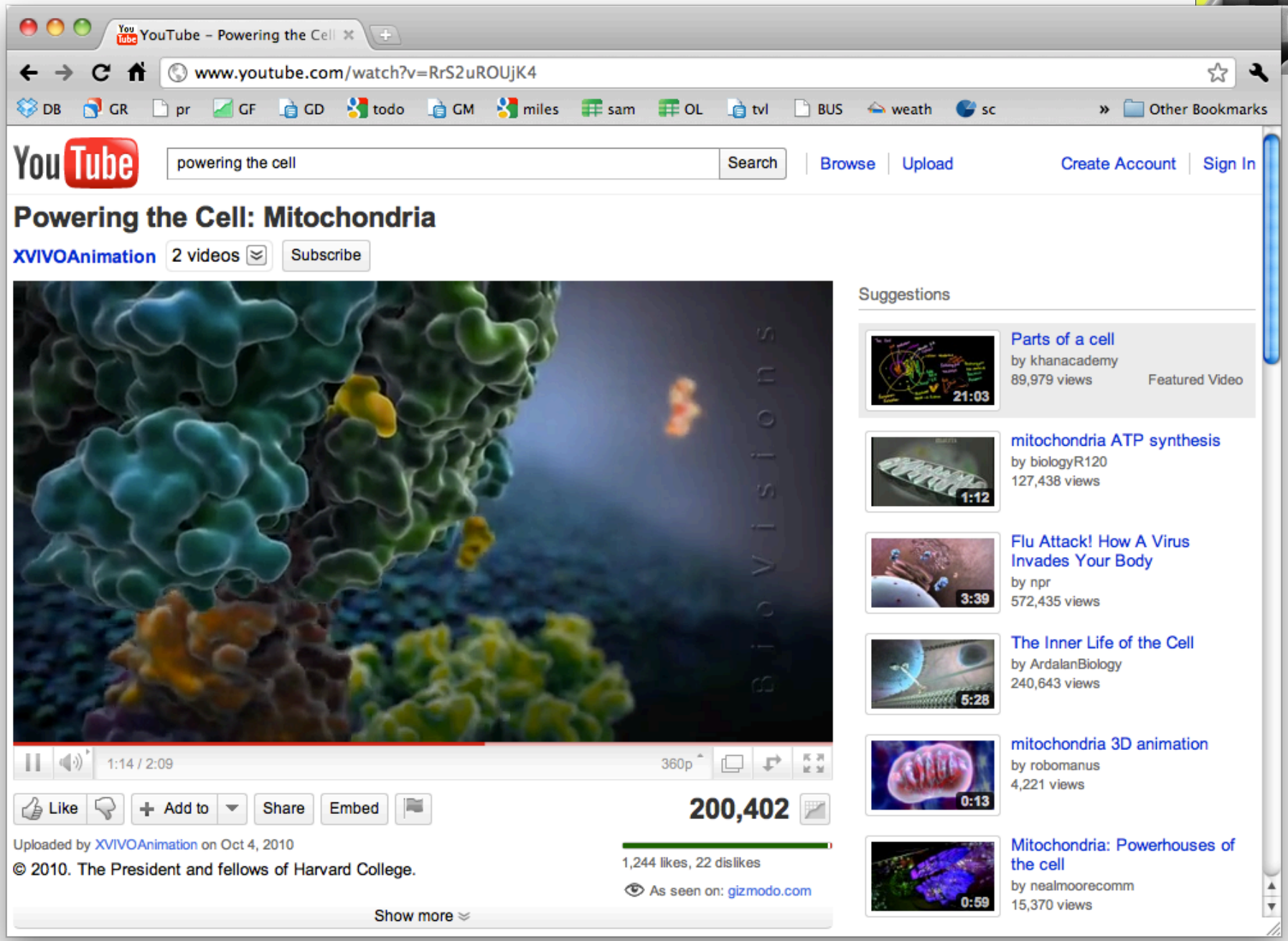
Figure-making software

- Adobe Illustrator, Photoshop
- Inkscape (free Illustrator-like)
- IPE (vector graphics)
- Microsoft Visio (PC only)
- OmniGraffle (Mac only)
- SmartDraw
- Origin (for plotting)
- Other favorites?

24 hours of air traffic



http://users.design.ucla.edu/~akoblin/work/faa/


YouTube – Powering the Cell
www.youtube.com/watch?v=RrS2uROUjK4
DB GR pr GF GD todo GM miles sam OL tvl BUS weath sc Other Bookmarks
YouTube
powering the cell
Search
Browse
Upload
Create Account
Sign In
Powering the Cell: Mitochondria
XVIVOAnimation
2 videos
Subscribe
1:14 / 2:09
360p
Like
Add to
Share
Embed
200,402
Uploaded by XVIVOAnimation on Oct 4, 2010
© 2010. The President and fellows of Harvard College.
1,244 likes, 22 dislikes
As seen on: gizmodo.com
Show more
Suggestions
Parts of a cell
by khanacademy
89,979 views
Featured Video
21:03
mitochondria ATP synthesis
by biologyR120
127,438 views
1:12
Flu Attack! How A Virus Invades Your Body
by npr
572,435 views
3:39
The Inner Life of the Cell
by ArdalanBiology
240,643 views
5:28
mitochondria 3D animation
by robomanus
4,221 views
0:13
Mitochondria: Powerhouses of the cell
by nealmoorecomm
15,370 views
0:59

Video methods journals (e.g., JoVE)

www.jove.com

Journal of Visualized Experiments

New Account | Forgot Password | Email

Click Here to Search | Search

Home | Browse | For Authors | Subscribe

Home | About JoVE | Editorial Board | Testimonials | Press | Sponsorship | The Team | Contact

What is JoVE?

Journal of Visualized Experiments (JoVE) is a video journal for biological research.

Sections

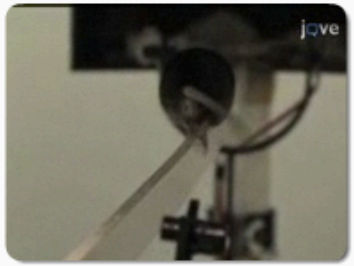
- All
- JoVE
- JoVE Neuroscience
- JoVE Immunology & Infection
- JoVE Clinical and Translational Medicine
- JoVE Bioengineering
- JoVE Basic Protocols

Follow

03/10/2011

Assessment of Motor Balance and Coordination in Mice using the Balance Beam

Tinh N. Luong*, Holly J. Carlisle*, Paul H. Patterson
Department of Biology, California Institute of Technology
* These authors contributed equally



Deficits in fine motor coordination can be assessed with the balance beam test. Performance on the beam is quantified by the speed at which the beam is traversed and the number of times the mouse slips on the beam.

View >>

03/10/2011

An Alternant Method to the Traditional NASA Hindlimb Unloading Model in Mice

J. Andries Ferreira[1], Jacqueline M. Crissey[2], Marybeth Brown[2, 1]
[1]Physical Therapy Department, University of Missouri, Columbia, [2]Biomedical Sciences Department, University of Missouri, Columbia

ISSN 1940-087X

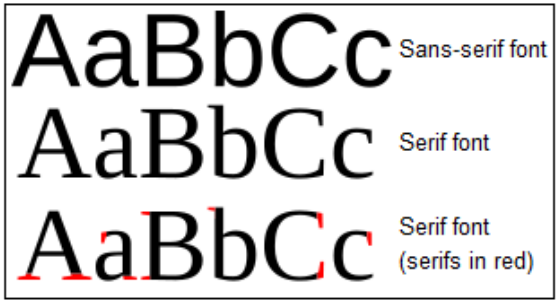
Rate:	Total:
40 Articles per Month	1003 Articles

http://www.jove.com/

Summary from Tufte

There are many specific differences between friendly and unfriendly graphics:

Friendly	Unfriendly
words are spelled out, mysterious and elaborate encoding avoided	abbreviations abound, requiring the viewer to sort through text to decode abbreviations
words run from left to right, the usual direction for reading occidental languages	words run vertically, particularly along the Y-axis; words run in several different directions
little messages help explain data	graphic is cryptic, requires repeated references to scattered text
elaborately encoded shadings, cross-hatching, and colors are avoided; instead, labels are placed on the graphic itself; no legend is required	obscure codings require going back and forth between legend and graphic
graphic attracts viewer, provokes curiosity	graphic is repellent, filled with chartjunk
colors, if used, are chosen so that the color-deficient and color-blind (5 to 10 percent of viewers) can make sense of the graphic (blue can be distinguished from other colors by most color-deficient people)	design insensitive to color-deficient viewers; red and green used for essential contrasts
type is clear, precise, modest; lettering may be done by hand	type is clotted, overbearing
type is upper-and-lower case, with serifs	type is all capitals, sans serif



Peer review: aims/tasks should be

- Specific (= what will be done)
- Measurable (= how you will measure the outcome)
- Practical (= can be done)
- Logical (= makes sense, on its own and in combination with other tasks)

Homework

- Please think twice about how you design and use figures in your proposal!
- Due next Friday 2pm
- Please bring paper copy to class too