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MAKING SENSE OF THE WORLD: HOW INFOGRAPHICS SHAPE UNDERSTANDING

BY KEITH TAM

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We live in an increasingly complex world. Our daily existence involves interacting with tens of thousands of messages, primarily through our vision (if one is visually able) and through many different physical and digital channels. Many of these messages might not even be meaningful or relevant to us, but demand our attention equally. Infographics become a shortcut for us to understand our world a bit more efficiently. Information no longer only comes to us as one-way communication for consumption. We interact with information and customise it for our own needs and circumstances of use in order to complete tasks, make informed decisions, learn, or even be entertained.

In his seminal monograph, *Information Anxiety*, first published in 1989, Richard Saul Wurman discusses the phenomenon of "information overload"—a source of anxiety caused by the proliferation of information of all kinds. He writes that only if we acknowledge—even celebrate—the fact that we are ignorant can we begin to deal with this contemporary condition. Trained as an architect with the late Louis Khan, he coined the term "information architecture" and considered himself an "information architect" (the term information architecture has since taken on a slightly different meaning). Wurman also shed light on how data and information are different, and knowledge and wisdom different still. While data is formless, raw, and meaningless, information is meaningful. It has been "transformed" (to use Otto Neurath's term) through the selection, framing, and editing of data, given a visible structure, given appropriate symbolisation systems, and given an aesthetic that is clear, usable, and persuasive for its intended users and context of use.

What are infographics?

The term infographics has been popular in the past decade or so, to the extent of becoming a household term. Short for information graphics, the word infographics refers to different types of visualisation of information intended to promote understanding and clarify ideas, concepts, and facts in easily understandable ways. Infographics form a branch of the wider practice of information design, which is a sub-discipline of communication or graphic design. Infographics, by nature, should therefore be user-centred—aiming to ultimately result in comprehension. Ambiguity is what information designers try to avoid.

Infographics can be found in many different genres of communication, media, and situations—from signage and visual instructions to editorial infographics in newspapers and magazines, and icons and pictograms in user interfaces. The applications of infographics are very diverse, and they can fulfil very different communication goals as well. The audience or user may be objectively informed through infographics, allowing them to compare things through visual evidence and hence come to their own conclusions and decisions; to memorise or learn a concept; to be able to see patterns of phenomena that cannot otherwise be seen, so that they can make informed decisions.

Are infographics neutral?

By their sheer looks, infographics may appear neutral, sober, and rational and consequently perceived as trustworthy and credible by the viewer. They may have a certain aesthetic or emotional appeal before the viewer engages with its content in detail. Just because something is presented in the form of an infographic leads to potential content credibility, which may or may not actually be there. So, infographics may potentially be deceiving. Although the pre-attentive appeal of an infographic functions in a useful way, one cannot stop at that level—deeper engagement with its content via closer inspection must be made, or else the usefulness of an infographic would be rather limited. Gauging an infographic's credibility and interrogating its content and sources is an important process. Infographics engage the audience or user on intellectual, as well as emotional levels. It communicates via hard cold facts presented in often neutral ways, yet also has the power to persuade via the association between the data and its visual presentation.

Contrary to popular belief, infographics can never be completely "neutral" or objective. The very process of transforming raw data into visual information relies on the designer or editor's personal viewpoint, judgment, or even values and beliefs, to select and frame data, and present it in an understandable way for a specific context of use.

The act of deciding what data to keep and what to eliminate already influences how the audience perceives the meaning of the data. The popular saying "data never lies" is only partly true, but the data itself does not carry any inherent meaning. It is only through the transformation and interpretation process, where meaning is given to data that "lying" can happen. While data never lies, information (and by connection infographics) may very well lie. Statistician, information designer and author Edward Tufte came up with the witty concept of "lie factor" in data visualisations: The lie factor equals the effect in the graphic divided by the effect in the data, then multiplied by 100. This, of course, is a whimsical commentary on how infographic designers have the ability to distort data and hence the audience's perception through infographics. Is this an ethical issue? It may well be. To think about infographics another way, it is not necessarily always rational, sober, and objective, but infographics may have persuasive power, too. Politicians, activists, NGOs, community lobbyists, and the like often use infographics as a persuasive tool, combined with advertising and promotional tactics to get the audience to side with them, garnering monetary and other kinds of support. Infographics are increasingly used for this purpose, blurring the boundary between two rather antithetical disciplines. Whether there is any lying involved during the process of transforming data to information, the visual presentation of information has a lot of emotive power. The affective quality can only be achieved when the data is seamlessly working in tandem with its visual presentation. Visual language and aesthetics cannot be considered separately from the data/content.

How do infographics work?

Infographics are about representation: The thing or concept is not there. We use something else to stand in to get the idea across. That something else is graphics—graphic language that consists of symbolisation systems (text, numbers, imagery, drawings, etc.) and structure (the use of space, grouping, clustering, part-whole relationships, etc.).

We use different kinds of symbolisation systems to convey information. As verbal language is not universal, visual language is the same. It has to be learned and is (usually) specific to different cultures. We need to consciously make sure that something can be understood across cultures. Nothing is truly "universal." Even so, people have constantly tried to create universal symbolisation systems that can be understood across cultures.

Context is extremely important. One cannot look at a piece of infographics without considering where, when, by or for whom it is designed—its circumstance of use. An infographic designed for one situation may not work in another context, situation or medium, in terms of content, presentation, physical properties, etc.

An infographic is not an aesthetic in itself. Infographics do not need to have pictograms, icons, pie charts, and numbers set in large sizes in order to qualify as an infographic. The visual language or style used can be extremely varied. Sometimes it is difficult to differentiate whether something is an illustration, a piece of typography, a comic strip, a map, or an infographic. These may all be infographics in the truest sense of the word, as long as they are designed to clarify information to promote understanding in their audience or user.

Infographics are a very large category of graphic communication that can appear anywhere: on a sign, in a publication (newspaper, magazine, scientific journal, textbook, etc.), in a seat pocket on a plane, on food packaging, on a piece of equipment, in a vehicle, on a digital screen (in a user interface), in a document, etc. There can be many different permutations. Depending on where they appear, there are technical and physical constraints that need to be satisfied. Scale is a very important consideration.

From data to information: a process of transformation

Data is not information. Data is raw, disorganised, without definite form, and its meaning is not immediately clear. It may be understood by machines, but not by human beings. Information, on the other hand, is data that has been processed so that it is understandable by human beings, is communicative, accessible, and fit for purpose. Information is data that has gone through a process of transformation (to borrow Otto Neurath's term). Information is something that can be used. Knowledge and wisdom, on the other hand, refer to information that has been assimilated and internalised by an individual. See Figure 1.

Structure and organisation lend an angle for understanding the content. They provide meaning and facilitate searching. Organisation also allows comparison to be made. Structure and organisation are some of the most important factors in determining the communicative value and usability of a piece of information design. Richard Saul Wurman uses the LATCH method to organise data: location, alphabet, time, category, and hierarchy.

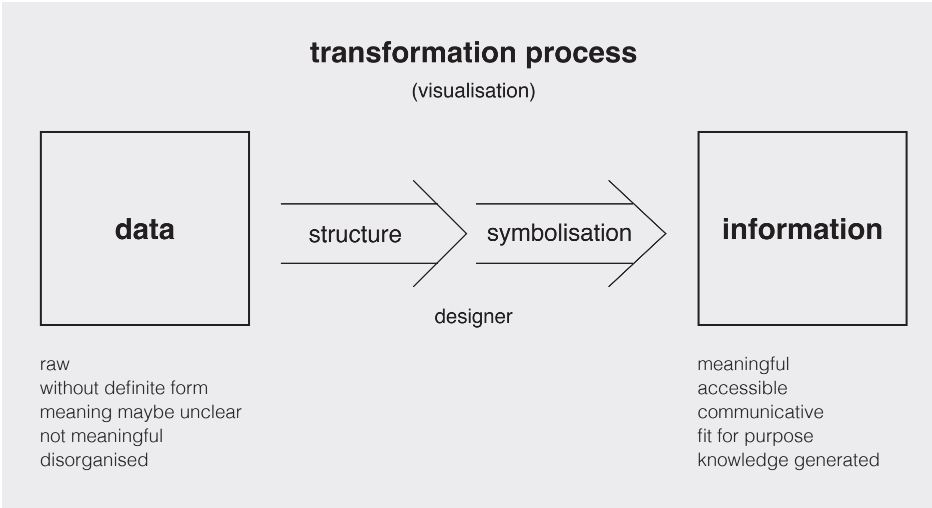
When encountering an infographic, the reader will approach it from a macro view first, which is a pre-attentive process. They need to be able to determine, at a glance, what the infographic is about, whether it is relevant or interesting to them, and how to go about reading and understanding. It is the "big picture" impression that one gets. Once the reader has decided to engage with it, a clear and logical structure will help them navigate around it and direct their eyes to look for and understand the specific information and delve deeper to reveal more.

The transformation process from data to information includes two aspects: (1) to give the data a structure that makes sense and (2) to select appropriate symbolisation methods for the data. Michael Twyman provides a schema for examining these two aspects. See Figure 2.

Along the horizontal axis are methods of configuration, which refer to different kinds of visual structures. "Pure linear" refers to a sequential structure. "Linear interrupted" refers to the normal reading process of text in paragraph format. "List" refers to an enumeration of items that are of similar status. "Linear branching" refers to a hierarchical, nested (or tree) structure. "Matrix" is essentially a table that allows comparisons to be made along the x and y axes. "Non-linear directed viewing" refers to a typical page layout, say, in a magazine where there are multiple entry points with elements in varying degrees of visual importance to guide reading. Finally, "non-linear most options open" refers to such artifacts as maps where one can start reading from anywhere without a definite visual hierarchy.

Along the vertical axis shows different modes of symbolisation: verbal/numerical (text and numbers), pictorial and verbal/numerical (image and text), pictorial only, or schematic (diagrammatic). The choice of symbolisation will depend on the audience and the circumstance of use.

Twyman's schema provides a useful framework for information designers to assess what options are available to them that are best suited to the communication problem at hand. In addition, in the age of media convergence, it would be important to consider how these methods of configuration and symbolisation adapt to different screen, print, and environmental contexts, taking into account the technology involved and constraints such as physical dimensions, resolution, viewing distance, budget available, and so on. All of these considerations now need to be put into the context of a user's journey.



Method of configuration

Mode of symbolization	Pure linear	Linear interrupted	List	Linear branching	Matrix	Non-linear directed viewing	Non-linear most options open
Verbal/ numerical	1	2	3	4	5	6	7
Pictorial & verbal/ numerical	8	9	10	11	12	13	14
Pictorial	15	16	17	18	19	20	21
Schematic	22	23	24	25	26	27	28

Figure 1. A diagram visualising the transformation process from data to information by Keith Tam. Image courtesy of Keith Tam.

Figure 2. A Schema for the study of graphic language by Michael Twyman, 1979. Image from *Processing of visual language*, Volume 1, Kolers, P. A. et al. (Eds.), New York: Plenum Press, P117–150.

Classic examples of infographics

Interestingly, although infographics have been around for a long time (the cave paintings at Lascaux, France from around 17,000 years ago could broadly be defined as infographics), information design as a profession only dates back to the 1960s. Early examples of infographics were not produced by designers at all, but by such personalities as an economist (William Playfair), a nurse (Florence Nightingale), and a medical doctor (Dr. John Snow). Even the pioneer of Isotype (International System of Typographic Picture Education) that gave rise to the wide adoption of pictograms in the display of information was not a designer by training, but a philosopher–social reformer. These early pioneers were not primarily interested in the aesthetics of information, but used graphics to illuminate facts that would not otherwise be possible to see, such as pure numerical data or text in prose form. The visualisation of information, therefore, was a reasoning tool. Patterns can be revealed through visualising incomprehensible data; relationships can become apparent when comparisons are drawn visually; the composition of an object, structure, or concept can be broken down into constituent parts for visual explanations; instructions and procedures organised into visual sequences and narratives can be easily followed and memorised, and so on. Efficiency and accuracy are the aims. The next section introduces 11 innovative examples of the graphic display of information from the 16th century until the 1980s that have transformed the way we acquire and assimilate knowledge, and shape the way we understand the world.

Visualising text through typography

Robert Estienne's Typographic Innovation in the 16th Century

Typography is the graphic presentation of textual information—a means by which written language is visualised and accessed by readers. Parisian publisher and printer Robert Estienne (1503–1559) devised ways to read and consult books with complex content. Working as a printer to King François I of France, Estienne printed and published a diversity of work, including classic texts, religious texts, as well as dictionaries. The innovation of Estienne's work lies in the way in which the systematic use of typographic variants (change in type size, small caps, and italics, etc.) to graphically code the textual information, making the searching of information more efficient. Estienne was a pioneer for combining various typographic variants on one page instead of using colour, saving on printing cost. Other navigation devices such as running heads and feet, indents, paragraph and section numbering, and indexes were extensively used. The text became graphical and diagrammatic, enabling the structure of the information to be visualised. Estienne's work laid the foundation for all forms of contemporary information and communication design. See Figure 3.

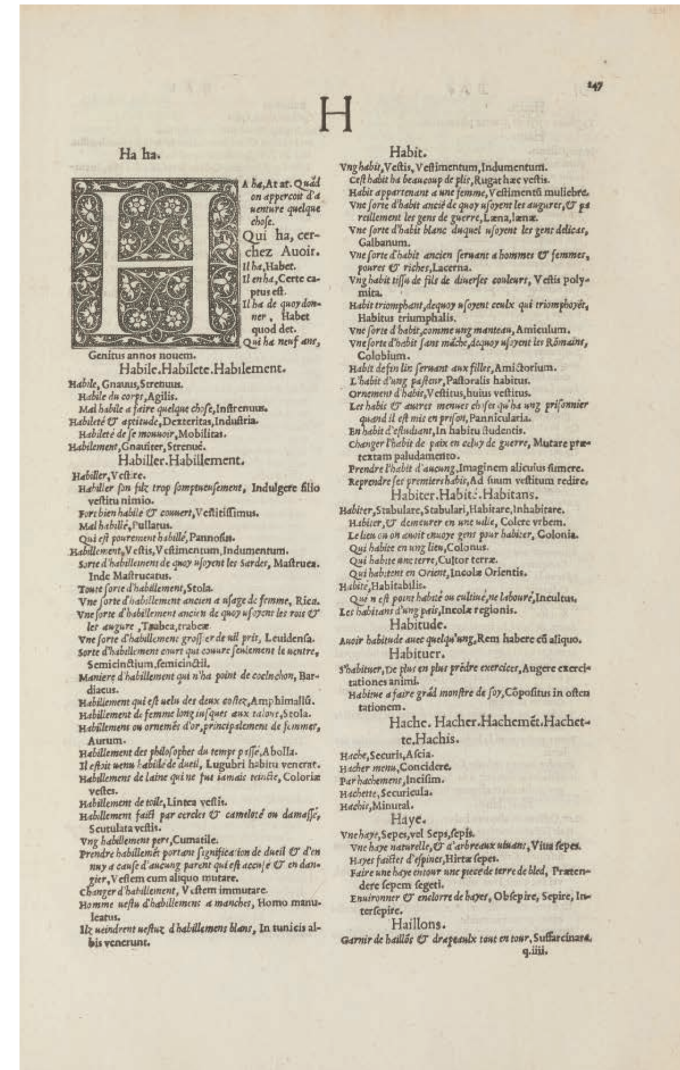


Figure 3. Page from *Dictionaire François-latin*, printed and published by Robert Estienne in 1549. Image from Wikimedia Commons.

Charting time

Joseph Priestley's A New Chart of History, 1769

British educator and polymath Joseph Priestley (1733–1804) was a pioneer in presenting historical events in a timeline format. In 1769, he created *A New Chart of History*, which he dedicated to Benjamin Franklin. The chart was created to accompany his lectures, as a tool for private study to visually reinforce the knowledge learned. Historical events are plotted against the horizontal axis, which show the passage of time. The stacking of the historical events divided by regions on the vertical axis shows whether the events happened concurrently or successively, and displays the interdependence rather than independence of events. The chart measures two feet by three feet, printed in black with coloured engraving added by hand. The chart recorded events within the timespan from 1200 BC until Priestley's days in the 18th century, and shows events in 106 countries or regions. This graphical presentation of history enabled time to be seen and visualised in one's mind. Priestley used the metaphor of a river with no beginning or end to describe his chart. This presentation of time as a horizontal flow gradually became the commonly accepted convention, congruent with the reading direction of many languages. See Figure 4.

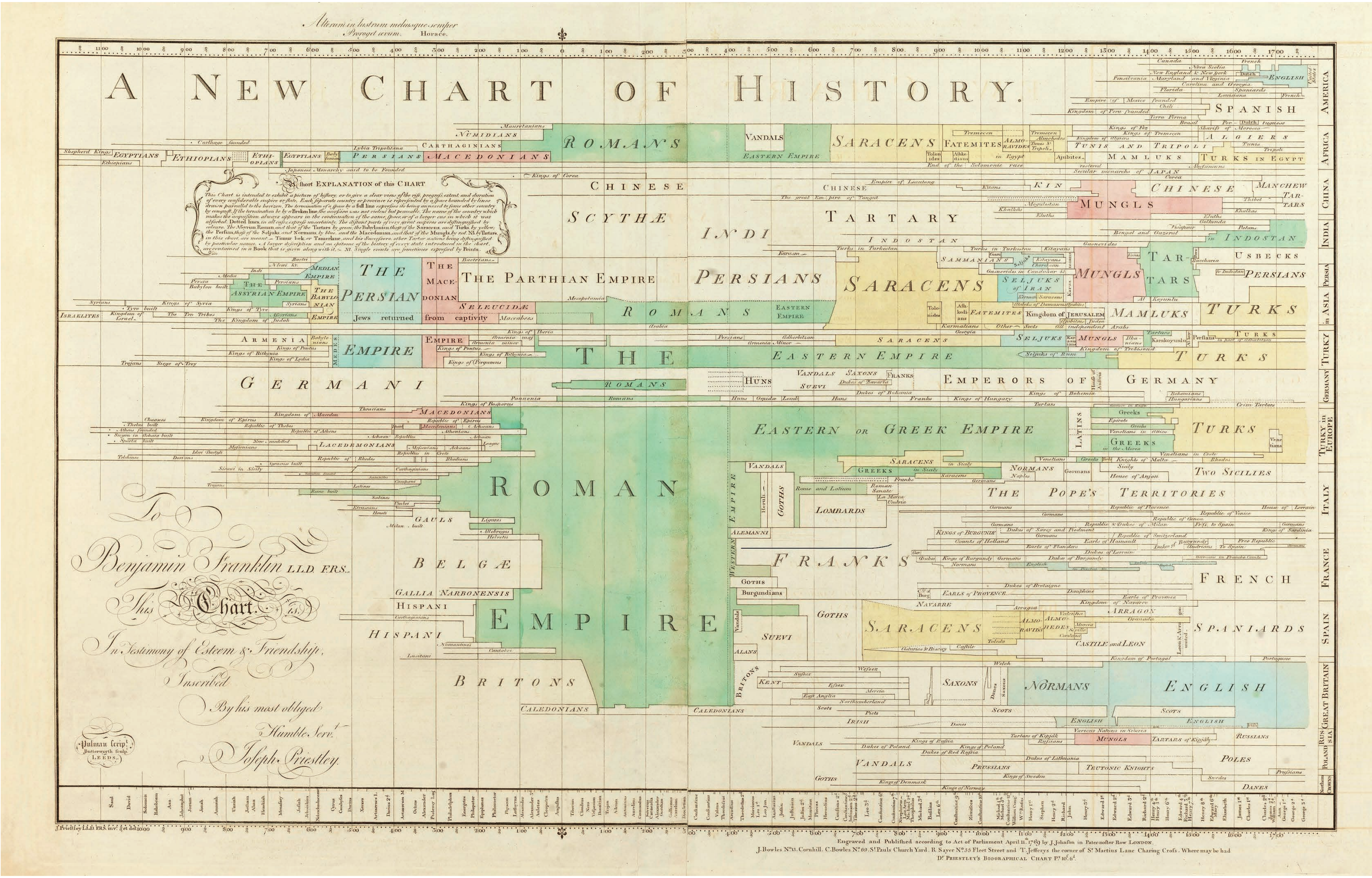


Figure 4. *A New Chart of History* by Joseph Priestley, 1769. Image from Wikimedia Commons.

Plotting data against time

William *Playfair's Commercial and Political Atlas*, 1786

In 1786, Scottish political economist William Playfair (1759–1823) published an unprecedented collection of statistical graphs titled *Commercial and Political Atlas*. The example shown here displays the price of wheat relative to wages within a timespan of 250 years, 1565–1821. By plotting the price of wheat against the weekly wages of a good mechanic and the reigns of British monarchs, correlations and comparisons could be drawn. This way of graphically displaying information was thought to be easier to digest by the average reader in contrast to extensive text and figures in tables. Mostly line graphs and bar charts were used, which, to the modern eye, can still be easily understood and now extensively used in business presentations and editorial infographics. Though they were unconventional at the time, they were readily accepted by readers. In Playfair's graphs, time was always plotted along the horizontal (x) axis, with magnitudes and amounts along the vertical (y) axis. See Figure 5.

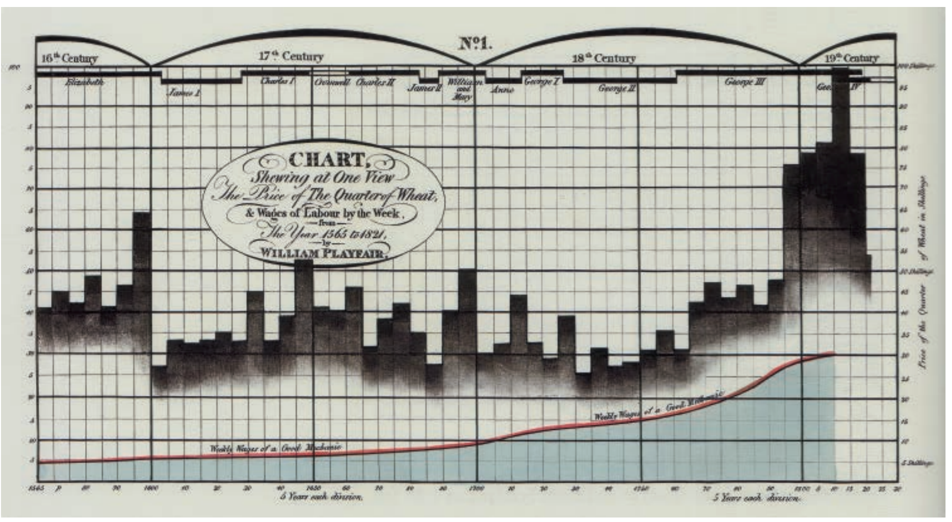


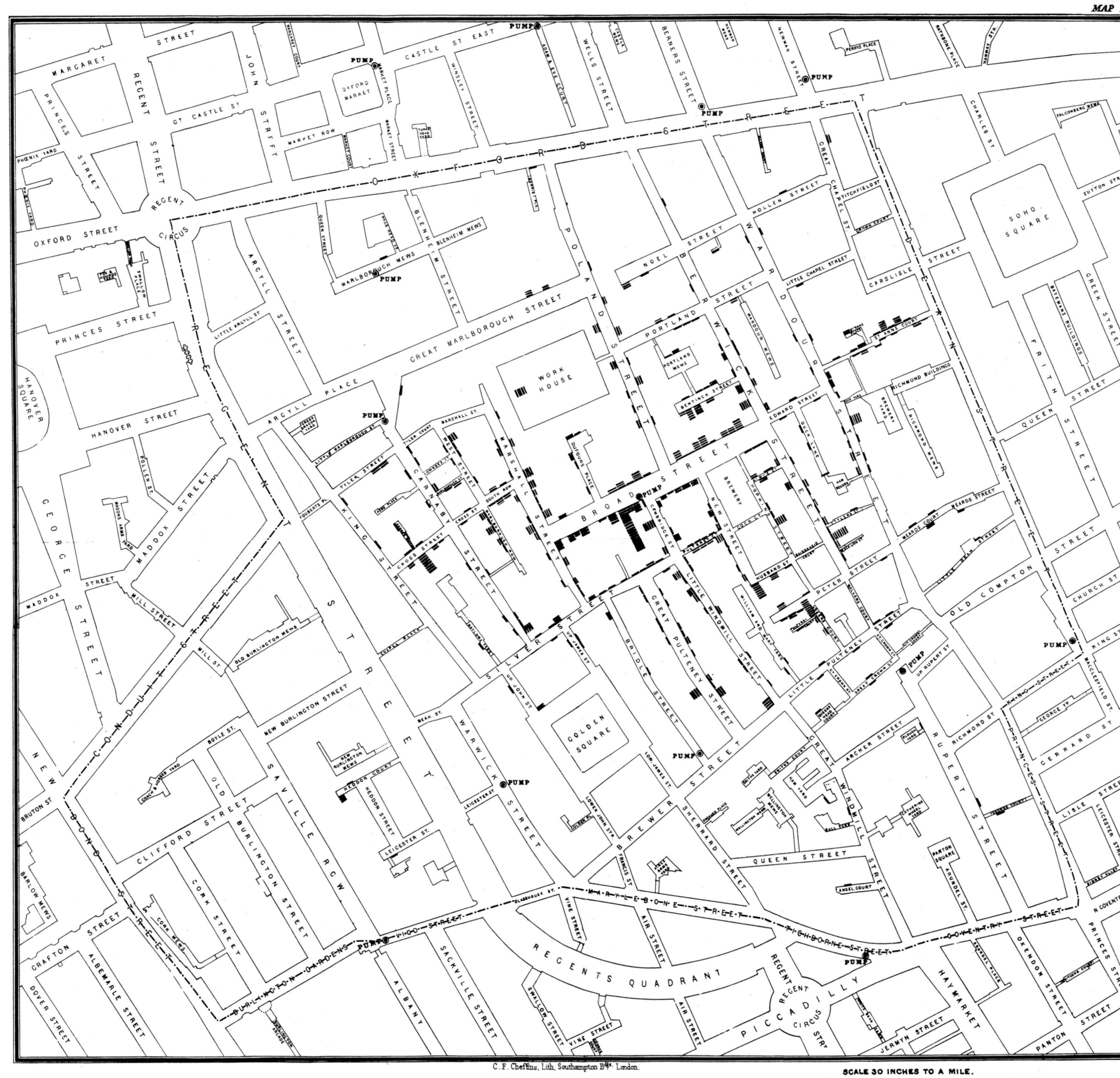
Figure 5. Chart Showing at One View the Price of the Quarter of Wheat, and Wages of Labour by the Week from 1565 to 1821 by William Playfair, from *Commercial and Political Atlas* by William Playfair, 1786. Image from Wikimedia Commons.

Plotting data on a map

Dr. John Snow's cholera map, 1854

Known as one of the founders of modern epidemiology, physician Dr. John Snow (1813–1858) used a graphic presentation of data as a decision-making tool to identify the cause of the cholera outbreak in central London in September 1854. Each death is indicated by a black bar, plotted against a street map of the area. The seven water pumps in the area are indicated by bull's eyes. Before Snow, it was widely believed that cholera was a disease spread through miasma in the air. By plotting the locations of the deaths against a street map and the locations of the public water pumps, the map verified Snow's theory that cholera is spread through water rather than air. The source of the epidemic was found to be the water pump on Broad Street, where most deaths were found. The pattern of the data and its correlation with the water sources would not have been easily discovered had the data simply been shown in a list or table format. The storytelling of this pioneering infographic is powerful and is an early example of data journalism. See Figure 6.

Figure 6. Map from *On the Mode of Communication of Cholera* by John Snow published in 1854. Image from Wikimedia Commons.



Advocacy through infographics

Nightingale Rose, 1856

Known as "The Lady with the Lamp," nurse Florence Nightingale (1820–1910) was a legendary figure from Britain who played an important role as founder of modern nursing. Working as a caregiver in a military hospital during the Crimean War in the mid-19th century, Nightingale recognised the higher death rates of soldiers compared with civilians and the importance of hospital sanitation in lowering deaths. She plotted monthly data of deaths by infection (blue), wounds (red), and other causes (black) on 30-degree segments in a circle, hence highlighting the overwhelming numbers that died from infection compared to other causes. Although the chart resembles a pie chart, the data is mapped onto the radii of the segments rather than the area. The blue area is graphically exaggerated, distorting the real effects of the data. The data would have been more simply and clearly shown as a bar chart, but that would not have given it its distinctive rose form. Nightingale submitted this chart to the War Office and successfully convinced its members to improve conditions at military hospitals. See Figure 7.

Visualising mathematics with color

Oliver Byrne's *Elements of Euclid*, 1847

Greek mathematician Euclid wrote his mathematical treatise *Euclid's Elements* that consists of 13 volumes around 300 BC. The first English edition was published in 1570 with black and white line diagrams and elaborate folded paper constructions demonstrating geometric principles. The 1847 edition titled *The First Six Books of the Elements of Euclid: In Which Coloured Diagrams and Symbols Are Used Instead of Letters for the Greater Ease of Learners* was published by Oliver Byrne (1810–1880). This edition uses three primary colours plus black to graphically demonstrate the mathematical principles behind geometric constructions, making them immediately apparent and self-explanatory. With the use of clearly differentiable colours, letters and numbers conventionally used to denote angles, lengths, and areas had been done away with. The seamless integration of coloured symbols into the explanatory text in prose format removes the need to refer back and forth between text and diagrams, which was very innovative at the time in terms of book design and printing. Although it was a pre-modern publication, it does have a modernistic aesthetic and is reminiscent of Piet Mondrian's paintings. See Figure 8.

A universal graphic language for public education

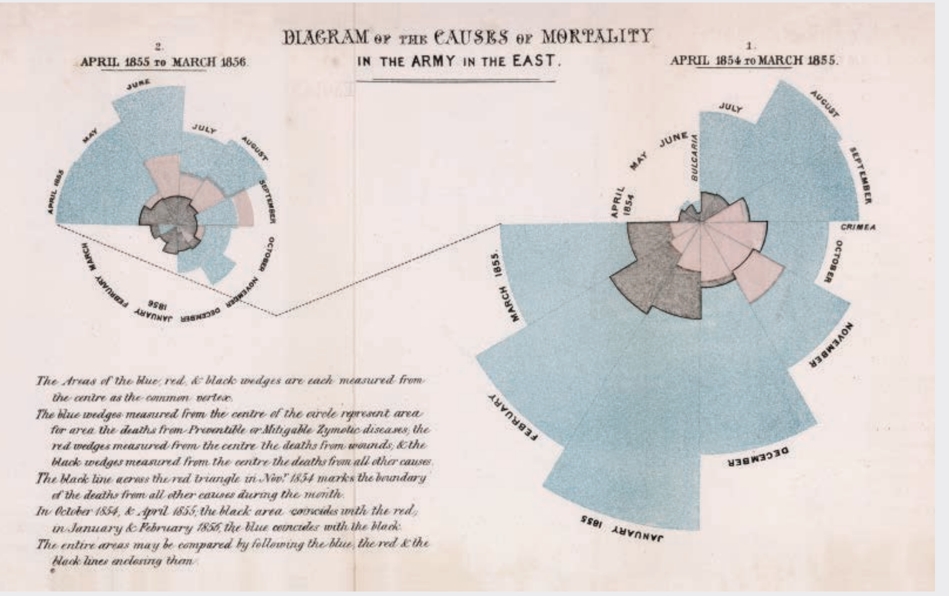
Otto Neurath's International Picture Language (Isotype), 1933

With the education of the public in mind in post-war Vienna, Otto Neurath (1882–1945) along with his wife Marie Neurath, artist Gerd Arnts, and his team developed the International System of Typographic Picture Education (Isotype) with a system of easily identifiable pictographic symbols and a set of principles for their applications. In 1933, Neurath published an extensive explanation of the principles of Isotype. The aim was to create a picture language that transcends national boundaries, as Neurath asserted, "Words make division, pictures make connection." One of the principles that Neurath insisted upon was the use of one symbol-unit to represent a fixed quantity (see Figure 10), rather than coding quantities to the size of the symbol itself (see Figure 9). This makes it easier to make direct, exact visual comparisons and eliminates the exaggerated graphical effect of large symbols. Neurath and the team's Isotype work has an important and lasting influence on the way statistical graphics are drawn to this day.

Figure 7. Chart from *Notes on Matter Affecting Health, Efficiency and Hospital Administration of the British Army* by Florence Nightingale published in 1858. Image from Wikimedia Commons.

Figure 8. Graph from *The First Six Books of the Elements of Euclid* by Oliver Byrne published in 1847. Image from Wikimedia Commons.

Figure 9 & 10. Otto Neurath, *International picture language: the first rules of Isotype*, London: Kegan Paul, Trench, Trubner & Co., 1936. Picture 25 & 27. Image courtesy of Otto and Marie Neurath Isotype Collection, University of Reading.



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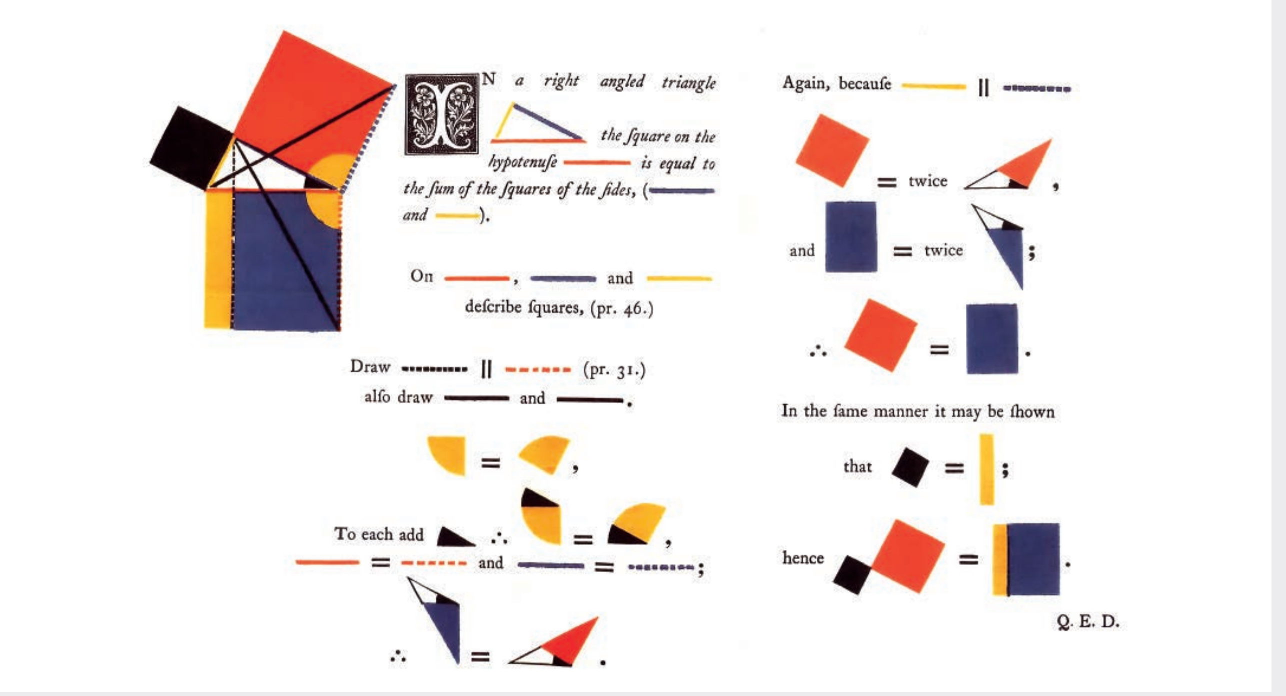

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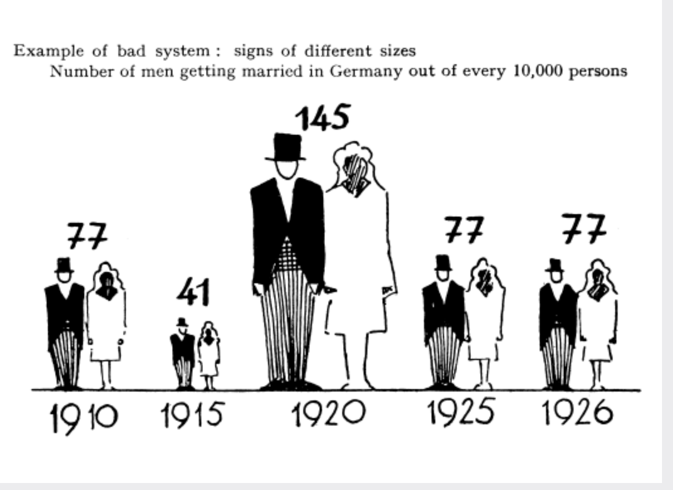

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Mapping without topography

Harry Beck's London Underground Map, 1933

The London Underground used to be operated by different railway companies and did not have a unified map of its extensive network. At the time, individual railway operators simply overlaid the railway lines on top of a geographical street map of London, which can be difficult to read due to the close proximity of the stations. Realising that the exact location of the stations is irrelevant when the railway network is underground, London Underground employee Harry Beck devised a diagrammatic representation of the Underground network that resembled an electric circuit diagram. By doing away with geographic accuracy and distorting the scale, the diagrammatic London Underground map focussed on what is important for railway users: the relationship between stations and lines. The only geographical landmark depicted in the diagram is the River Thames. All lines are presented as either orthogonally or at 45-degree angles. The directional relationships between the stations are generally maintained, though distances have been distorted in order to accommodate more stations in the central area. The general principles for constructing the London Underground map has largely remained unchanged to this day, although the system has grown extensively. This map has formed a mental map of London for many over its long history and has provided a model for the schematics of numerous railway systems around the world. See Figure 11.

Figure 11. London Underground map designed by Harry Beck, 1933. © TfL from the London Transport Museum collection.

Branding with pictograms for a global audience

Otl Aicher's Olympic games pictograms, 1972

Nearly four decades after Otto Neurath and the team's Isotype system was published in *International Picture Language*, German graphic designer Otl Aicher (1922–1991) devised a highly influential system of pictograms for the 1972 Summer Olympic Games held in Munich, Germany. In his capacity as design commissioner of the Games, Aicher came up with a cohesive graphic system that included a set of pictograms for wayfinding and public facilities, as well as all 20 sporting events. The pictograms were simple shapes constructed on a grid using only orthogonal and 45-degree angles, capturing each Olympic sport's most characteristic elements and stripping away everything else. Overcoming language barriers is a requirement for a global event with participants from more than 120 countries' and Aicher's pictograms elegantly delivered communication to this multi-cultural audience with clarity and precision. The result was a timeless graphic design classic that has won critical acclaim and inspired many iconographic designs since. See Figure 12.

Figure 12. Two colour poster showing all pictograms designed for Munich Olympic Games 1972 by Otl Aicher. © Estate of Otl Aicher/German National Olympic Committee.

Information of a monumental scale

Maya Lin's Vietnam War Memorial, 1981

Although this example is not strictly speaking an infographic, it represents an architect's information design thinking applied at an architectural scale for a historical monument. Maya Lin, an American architect of Chinese descent, used data visualisation as the monument's main concept. The colossal loss of life during the Vietnam War was an inspiration that gave rise to the form of the monument. The Vietnam War was fought for 19 years and 180 days between 1955 and 1975. The compressed diamond form of the monument is incised into the landscape, visually mapping the number of deaths over time in the horizontal axis. The form contains the names of 58,000 soldiers organised by year of death, gradually increasing in number from low to high, then tapers down again. While the form is a graphic representation of data, it also metaphorically represents a scar. The way the names are organised does not make the searching process efficient but powerfully contemplative. This example demonstrates that data need not be cold and impersonal, nor restricted to two-dimensional surfaces. Through visualisation, data have the potential to create bold and emotional statements in spatial environments. See Figure 13–14.

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Figure 13 & 14. View of Vietnam Memorial designed by Maya Lin, 1981. Image from Wikimedia Commons. Image courtesy of Sailko.

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Graphical user interfaces and iconography

Apple's Macintosh graphical user interface, 1984

The Macintosh computer was introduced by Apple Computers in 1984 and it was the first mass consumer personal computer with a graphical user interface (GUI). Equipped with a mouse in addition to a keyboard, Macintosh also boasted an operating system that used the "desktop metaphor" with instantly recognisable, whimsical icons to denote functions and commands, designed by Susan Kare. There were overlapping "windows" resembling pieces of paper on a desk. Paper, folder, and trash can icons represented a digital document, a file directory, and a way to delete items, respectively. A pull-down menu bar was used for selecting commands on the screen instead of having to memorise and input the command via the keyboard. Human interface guidelines were created to ensure usability and universality for software developers when designing for the Macintosh operating system. While not entirely original, the Macintosh popularised the graphical user interface of the Xerox Star developed at Xerox's Palo Alto Research Centre and made it a commercial success. Apple's user-centred approach to the graphic presentation of information enabled the average consumer without technical know-how to operate a computer and set the standard for all subsequent graphical user interfaces that we are using today. See Figure 15.

Figure 15. Apple's Macintosh graphical user interface, 1984. Image courtesy of history-computer.com.com.