

Visual Alpha-Beta-Gamma: Rudiments of Visual Design for Data Explorers

MAREK KULTYS, MA

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ABSTRACT This article discusses terminology useful toward the creation and discussion of visualizations. It continues and expands on a hands-on tutorial delivered by the author at the VisWeek2012 conference in October 2012 in Seattle, WA.

Today, many fields of scientific activity have become increasingly reliant on visuals as means of dissemination, exploration, and analysis of information. Consequently, either directly or through computer coding, many scientists become *de facto* image-makers. This article aims at providing basic introduction to visual language to those data explorers, those who depend in their fields of activity for producing (creating or generating) images. Five elements (the vocabulary) of visual language and four visual structures (the grammar) are defined, explained, and discussed. These aspects of the vocabulary and grammar of visual language are then elucidated through pictorial examples, thus presenting basic interdisciplinary knowledge of the subject from a design practitioner's perspective.

The article concludes with a bibliography with recommendations of valuable readings for further investigation of the topic. It is hoped that the paper provides useful background to be informedly used in readers' own image-making activities.

INTRODUCTION

Image-making was the general theme of a hands-on tutorial titled "Good Practice of Visual Communication Design in Scientific and Data Visualization" conducted by the author at the VisWeek2012 conference in Seattle, Washington, on October 16th 2012. Explored from a range of perspectives, the tutorial provided its participants with an overview of selected visual elements and structures available to an image-maker. It showcased successful as well as failed visualization examples, last but not least, the tutorial facilitated a live sketching exercise in which all tutorial participants were able to freely experiment with different ideas and strategies toward representing data.

In this article we present and expand on the content

of the first part of the VisWeek2012 tutorial: a lecture about visual language—the language through which the image-maker speaks to their audience. We will discuss visual language under two aspects. The first deals with visual vocabulary and outlines five distinct elements present in graphic visualizations: *point, line, area, color and typography*. The second part discusses four kinds of relationships between visual elements used in visualizations—the visual grammar of an image: *grid, negative space, synthesized seeing and time*. Each feature of visual language examined here is briefly discussed and accompanied by instructive illustrations.

The article is primarily addressed to those data explorers (scientists, analysts, researchers, visualization experts) who strive to represent complex content visually, but may be lacking in the basic knowledge and understanding of visual language skills. Aiming at briefly and broadly introducing the reader to the most basic topics of visual design as seen from the practitioner's point of view, as well as confined to the format of a journal article, the author took the liberty of arbitrarily selecting examples for discussion in this paper. Although a well-informed and visualization savvy reader might find this selection incomplete, inconsistent, or even disputable (there is a number of much more systematic and comprehensive studies of visual language available), it is hoped that (for a start) a curious data explorer untrained in image-making will find this article eye-opening, instructive and—with the help of the extensive bibliography concluding the article—a good vantage point for further independent study of the topic.

VISUAL VOCABULARY: POINT

The smallest unit of visual form is a point. Graphically a point is a dot—a tiny material surface characterized by color, shape, and other possible attributes. Additionally, we will define a dot as having a position on a plane. Scientifically it is an abstract entity, a variable, a set of coordinates with a precise location in mathematical space.

Both the graphical and mathematical perspective on the point is true for scatterplot diagrams, where any point is a carrier of numeric values located on chart axes. Thus a point can indicate a very precise moment in time, pinpoint a specific location in space or any other measurement on a scale.

It is a valuable observation to understand that a point is primarily a natural phenomenon. The sky at night contains hundreds of visible points, the macrocosm of shiny stars, each indicating a specific location in the universe measured by the age of light traveling towards us. Observing the stars and trying to work out how the universe

works has always been one of humankind's most ancient pursuits. In the opposite corner of the scale of things there is an atom, a droplet, a primitive living cell, a microorganism... We do not necessarily know how an atom looks like, but we know it as a localized mass and an epicenter of forces—both anchored in a specific point in space.

Pointillists observed the world around them as a collection of interrelated points. They were a group of artists who in late 19th Century developed a new painting technique in which small, discrete spots of pure color were systematically applied on canvas to collectively form a meaningful picture. Pointillism relies on the ability of human seeing to blend distributed colors spots into a combined tone. Most notable pointillist painters were Georges Seurat, Paul Signac and Camille Pissarro.

Today, many imaging technologies rely on the same principles, which underlay pointillism. In CMYK printing an image is developed by applying patterns of discrete dots in a meaningful combination. In fact, the only mark that modern digital printers can produce is a point of ink. In a very similar fashion RGB displays generate complex images by combining colored points (pixels) in a meaningful pattern. Contemporary image-maker should be aware of the fact that this is how every digital visualization is produced today, be it on screen or in print.

VISUAL VOCABULARY: LINE

“Breadth-less length” is how line is described in Euclidean geometry—a continuous extent of length that has no breadth. Mathematically it is an abstract concept, extending infinitely without beginning or end. Pick any two points in space and you will be able to stretch a line through them. A line segment on the other hand starts in one point and ends in another, and marks the shortest way between those two. A line can also join separate point into meaningful groups. Three lines connecting three points make up a triangle; a hendecagon comprises eleven even lines. Little wonder that first astronomers felt compelled to draw imaginary lines in night skies—ancient star constellations help us identify and locate heavenly bodies until today.

From a designer's perspective a line is a function of time. It is a single continuous form created by a pencil tip scratching on the surface of paper. A line is hence one of the most primitive graphic entities—an elementary form of expression in drawing, sketching, diagramming, mapping—be it manual or digital. Whether straight, crooked, spiraling, or open or closed, it always becomes a notation of point's travel in space over a period of time.

Being such an important element of visual language, a line has hence a variety of roles to play. It separates one

area from another, therefore, is the first step when creating divisions on blank surface of paper or screen. A line can indicate length and direction—both these abilities are important for visualizing information and cartography. A meandering line can carry valuable information about the shape of a continent, resembling someone's face profile, or depicting a specific bone taken from human skeleton. Hand-drawn lines always carry some artistic qualities: bringing dynamism, gesture, or emotion to an image. Expressing these notions with a single line is possible owing to the fact that a line is a visual object—and it has thickness. Draw a vector line in a computer program and increase it's thickness until it is difficult to decide, whether it is seen is still a line or maybe already a rectangle... Tricky, is it not? There is a fine line between these two cases and one's judgement would usually depend on one's context.

All these characteristics of a line provide potential for carrying information. Stock exchange performance can be represented with a single line shooting up, then diving down, up and down, up, down... A curved line drawn on the world map calculates an orbit of a satellite passing above continents and seas. A network of intersecting colored lines can represent a whole rail transportation system in busy metropolitan areas within London, Moscow, Tokyo, or Warsaw. In all these cases lines are saturated with information of various kind: time, value, location, direction, train service, etc. In contemporary world we continuously rely on complex information but not often pay much attention to the fact that it is often read from such a rudimentary yet efficient form—a simple line.

VISUAL VOCABULARY: AREA

An area can be marked out between at least three intersecting lines or created by a line in motion. A razor blade reveals an area of naked skin from beneath a beard and shaving foam; several strokes usually suffice to shave one's whole face. A very specific instance of dividing space with a line is when we draw a loop or any other closed polygon. It creates a border, an inside-outside relationship between two areas which we call shapes. Because we also like to recognize familiar shapes in abstract forms (who has never spotted a cumulus white elephant or a cirrus rabbit in the skies?), we tend to ignore the objective, formal appearance of outlined areas and fill it with our personal associations. And this poses problems for image-makers.

From the practitioner's point of view, the under-defined inside-outside relationship often leads to ambiguity. A circle (FIGURE 1A) can represent virtually anything. Is it a ball? Is it a hole in a wall? Or maybe a ring? Each interpretation is true until a watchful image-maker provides us with



formal hints. Additional lines of internal structure defining the area inside the circle transform it into a basketball (FIGURE 1B). If a pattern appears on circle's outside, we learn that the ambiguous area is in fact a hole (FIGURE 1C). Drawing another circle inside the first one prompts us to see them related; our mind fills the gap for us, and a white area emerges between the circles (FIGURE 1D).

Wary of many ambiguities of visual vocabulary, an informed image-maker will always saturate an image with just enough necessary context information to allow for its intended interpretation. Let us consider an example borrowed from the author's own design practice—illustrating cell receptors anchored in cell's membrane. Here we can see a receptor embedded in a lipid bilayer (FIGURE 2A), which divides the frame into two distinct areas: above the membrane (where the main part of the receptor resides) and below the membrane (with ends of receptor's trans-membrane domains). For a knowledgeable reader this image alone may suffice to identify the inside of the cell (cytoplasm) and its outside (environment). This is possible owing to the fact, that our educated reader can be familiar with microbiology visualizations and capitalizing on this experience, she/he would understand the image in spite of ambiguities. However, for those readers not educated in life sciences, the A image might not be enough, because they need additional cues to help them see the continuity and physicality of cellular structure. When discussing the cell alone, we benefit from having cell's inside area filled with a pattern or shade (FIGURE 2B), which shows that the membrane encloses internal material of some kind. Giving definition to this inner area is important, because it allows us not only to juxtapose it with the empty background, but also provides extra interesting data on cytoplasm density. Same principle applies when the focus is on cell's environment (FIGURE 2C). Here again, while emphasizing the fact that the cell is not levitating in white emptiness but suspended in a solution, we also provide approximate information on this solution's qualities—namely its concentration represented by the scattering of dots. Finally, we can combine the B and C images together, to form one comprehensive image presenting a whole range of information at once (FIGURE 2D). Our image thus dense with extra information will always outperform those with less to tell.

An informed image-maker strives to observe her/his own work from the perspective of a prospective viewer. Forgetting now and again our specialist professional background is always good tactics to reassure us, that the information and visual cues we provide in our images is sufficient for non-expert audiences.

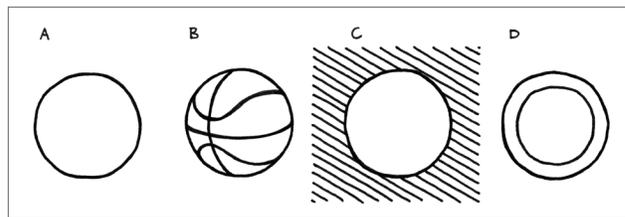


FIGURE 1: *Ambiguous circle. Image-maker helps the viewer interpret the shape by providing visual cues (redesigned and redrawn after Adrian Frutiger)..*

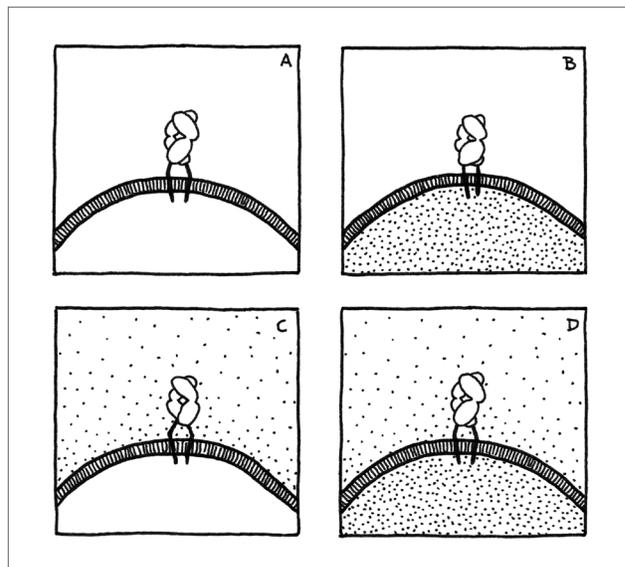


FIGURE 2: *Image-maker increases information density by adding patterns to eliminate inside-outside ambiguity.*

VISUAL VOCABULARY: COLOR

Color is a visual sensation created by objects reflecting specific wavelengths of light—the visible spectrum of electromagnetic radiation. A lemon appears yellow because it reflects rays of light only in those wavelengths, which are in the yellow region of the spectrum, and absorbs all other wavelengths. However, if we observe the same lemon through a blue-stained glass, it will appear green instead of yellow. This is because the blue glass changes the frequency of yellow light reflected from the lemon and shifts it to the green part of the spectrum. Obviously, such visual intervention does not change lemon's properties—it only changes the sensation of the light captured by our eyes' retinas.

Color is a most subtle and tricky tool in image-maker's repertoire. Many artistic and scientific careers have been dedicated to studying color and color perception (color theory), and there is still a lot to be learned. Here, we will

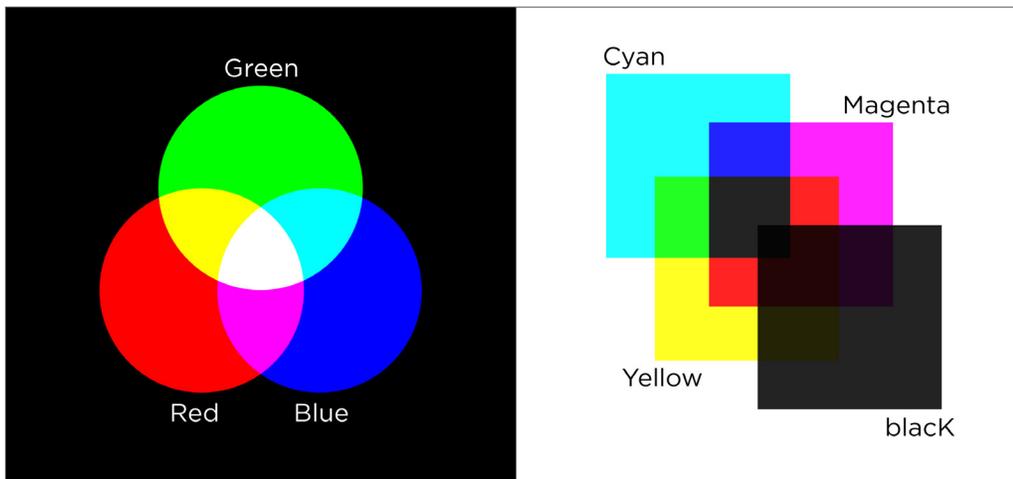


FIGURE 3: *Two color models. RGB = Red + Green + Blue light. CMYK = Cyan + Magenta + Yellow + black ink.*

focus on the use of color in design practice.

Colors we use in print or on screen are composites—selected tones are produced by carefully combining basic colors of paints or lights (FIGURE 3). Most commonly we use four primary tones of ink in print (Cyan + Magenta + Yellow + black = CMYK color model) and three elementary tones of light for display (Red + Green + Blue = RGB color model). The RGB model produces additive colors, because by introducing combinations of red, green and blue lights to darkness we can attain the whole gamut of tones. RGB culminates in pure white light produced from all three lights shining with full power. The CMYK model offers subtractive colors, as four process inks take away brightness from white paper. This process culminates in rich black—four blots of primary colors applied in one spot. (Technically, black is necessary because reflective light is not as “pure” as incident light, otherwise CMY would render black in the same manner as RGB renders white.)

In image-making and visualizing color can perform specialized functions. It can act as a noun and 1) label specific objects or structures—in London Underground network diagrams the Central line is always labelled red and the District line green. Also traffic lights operate a universal language of color: go when green, stop when red. Color can be employed as scale or quantity to 2) measure a given variable—we use of that function in elevation maps where ocean depths are measured with shades progressing from dark to light blue. Nature uses color scales less directly but still very effectively to indicate when an apple or a tomato is finally ripe. Thirdly, color is often used in image-making to 3) represent reality and imitate things—maps showing green deserts and green rain forests will be undoubtedly misunderstood, because the

use of colors will not adhere to our everyday experience. In more complex images color can also contribute to 4) building space and depth—ordering of plans in an image can be suggested by progressive desaturation of distant objects, which is known as aerial or atmospheric perspective (see “Mona Lisa” by Leonardo da Vinci). Finally, color can also 5) decorate and enliven provided that it is done with a purpose—Torre Agbar skyscraper in Barcelona is a good example of such decoration with glass elevation effectively illuminated at night and vividly opalescent in daylight.

A knowledgeable image-maker should learn about the nature of color, color models and color functions, additionally, they should remember three rules when deciding on the use of color. Firstly, 1) no more than six to eight distinct colors should be used to label objects that appear in close proximity to one another. The human eye can effortlessly distinguish no more than approximately eight hues. We all have struggled with diagrams or charts where colors are too similar to differentiate between the categories they purportedly label. If twenty variables are to be colored in one chart, a skilled image-maker should consider ways of restructuring the data (sub-categorization, using several charts, etc.) Secondly, 2) colors used to measure should be used intelligently and with respect for the whole scale they represent. It is common practice to use full-spectrum rainbow color scales to quantify data in maps and diagrams, even though the full spectrum scale does not offer a visually uniform distribution of hues (FIGURE 4A). Extreme ends of the rainbow scale tend to exaggerate value fluctuations and visually dominate an image, whereas the middle section of the spectrum lacks sufficient definition and contrast to give true justice to the whole range of values in that part of the rainbow

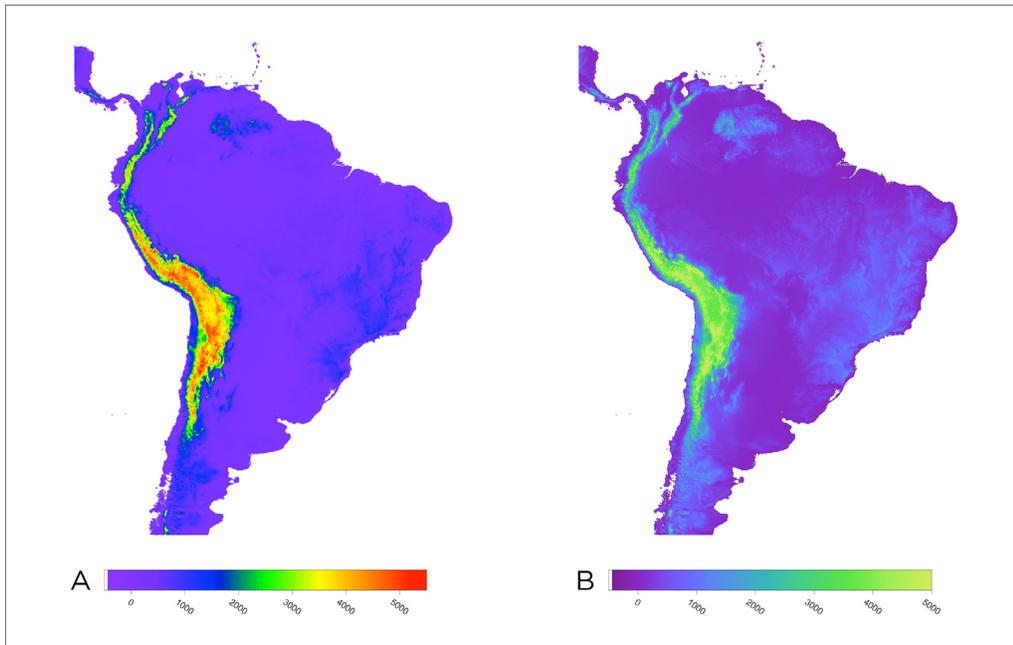


FIGURE 4: Color scales. Image-maker's duty is to faithfully map colors onto a data set. Perceptual palette B utilizes color and its properties to represent terrain elevation much better than palette A. Image by Matteo Niccoli, Mycarta, 2013 (Modified.)

scale. To avoid color exaggeration and misrepresentation one should employ those color scales, which give equal fidelity and prominence to both central and extreme scale sectors (FIGURE 4B). Thirdly, 3) when choosing colors one should always be cognizant of those who possess color deficiencies. There are many types of color deficiency, most of which can be simulated with popular online tools (e.g.: www.colorschemedesigner.com); these sources provide advice on inclusive color selections. An informed image-maker strives to design for the widest possible audience—in the end it is in everyone's best interest. Color scale presented in FIGURE 4B is an example of this highly appraisable design policy of inclusivity.

VISUAL VOCABULARY: TYPOGRAPHY

Letters and other typographic symbols are graphic shapes that carry variable levels of meaning. Although a literate person sees the same letterforms as an alphabetic person, it is the literate individual who can collectively read them, thus accessing abstract meaning encoded within the text. Typography, and writing in general, are visual representations of language. We rely on typefaces to achieve this within typographical constructs. Today, we use fonts—electronic data files containing characters, glyphs, and other symbols, whereas in traditional letterpress printing there were metal blocks with raised, mirror image characters that permitted their inking toward the typesetting process.

Typographic means of expressions is essential for contemporary image-making. Typographical knowledge permits an image-maker to skillfully edit stand-alone text, label a map, or create a legend to explain a visualization. Here we will discuss the anatomy of a typeface, as well as basic functions performed by typography in visual communication.

The Latin alphabet is organized with the words wrapped downwards to form columns of parallel lines reading from left to right (i.e., in the Westernized manner). Characters are set on a horizontal axis called the baseline (FIGURE 5). To identify this baseline locate the bottom horizontal edge of letter “Z”—it abuts the baseline. The x-height is type's second elementary dimension. It is the space between the baseline and the upper edges of the lower case letter “x” (known as mean line). Within the x-height resides the body of the character. Lower case letters a, c, e, m, n, o, r, s, u, v, w, x, and z can be fitted within the x-height space almost entirely. Those portions of letters b, d, f, h, i, k, l, and t that remain above the mean line are called ascenders. Consequently, those portions of letters g, j, p, q, and y residing below the baseline are called descenders.

The specific letterform design of each font makes it more suitable for one user's purpose, or task, and less suitable for another. Because two fonts of the same numeric size measured in points (e.g.: 12pt) can have strikingly different x-heights, their legibility effectively depends on the x-height value. The larger it is, the bigger the characters

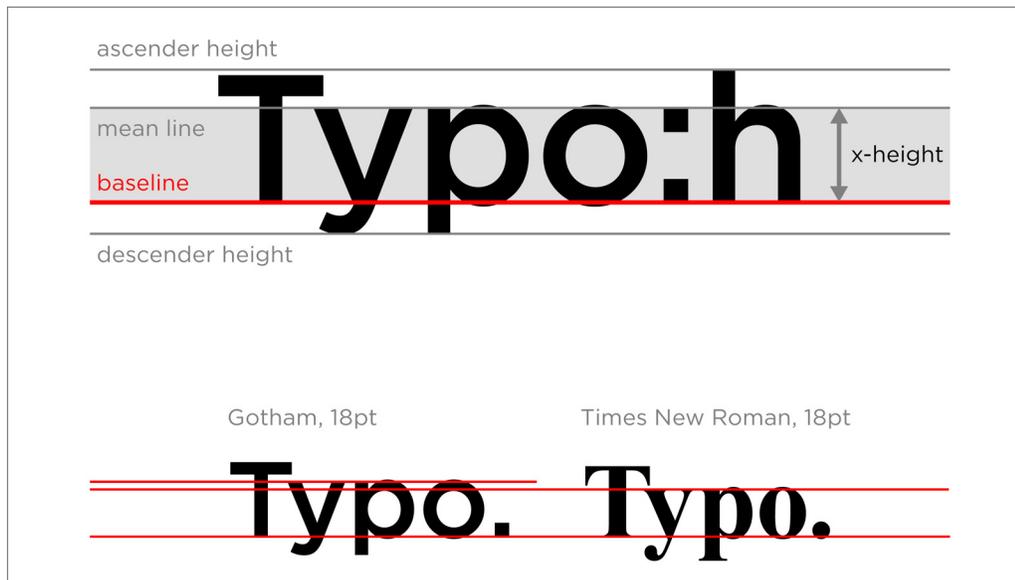


FIGURE 5: *Typography is organized on a baseline. x-height comparison reveals differences in typeface volume between two distinct fonts of same size.*

of a particular font appear to the reader. For instance, text set in Gotham Book (size 18pt) will appear bigger font than the same text set in Times New Roman Regular (18pt), because Gotham’s x-height is approximately 25% greater than x-height in Times. This seems not much, but when text is displayed dynamically and requires high legibility this 25% makes important difference. Furthermore, digital displays usually promote larger x-height fonts, because it allows for more flexibility in typesetting and improves overall experience and ease of reading.

In editorial and image-making, typography plays more of a role than just visualizing language. It provides the means of structuring and organizing a text message through basic typographic variables, such as: font size, font weight (light-regular-bold), line spacing, positioning, alignment and justification (justify right, justify left, align to centre), etc. Using typography an informed image-maker will be able to introduce hierarchy to text, which can be attained by differentiating font size or form. Most often two font forms (serif and sans-serif) and three font sizes (e.g. 9pt, 12pt and 21pt) is enough to structure a complex texts in a transparent and attractive fashion. Other means of text manipulation such as character color (not necessarily venomous reds—consider toned greys) and indentation help identify and group information types, as well as emphasize its key parts. The old motto “less is more” summarizes the best part of all typographic works ever designed.

VISUAL GRAMMAR

Once an image-maker learns and understands the visual vocabulary, it is time to become familiar with more global relationships and interactions that happen between groups of elements of visual language. Just as for written or verbal language through which employ syntax and grammar to assign intended meaning to a collection of words, so is the case for visual language whereby we observe structures and rules that put our visual vocabulary in context.

We will discuss four arbitrarily selected structures: design grid, negative space, synthesized seeing, and time. This selection is informed by observations made at scientific conferences, where the author had an opportunity to identify most common mistakes and weaknesses in the ways scientists visualize and communicate their work. It is hoped that becoming familiar with the basics of visual grammar will help all curious data explorers improve their image-making skills.

VISUAL GRAMMAR: GRID

Designers use grids to impose structure on content; to provide content with hierarchy and architecture, and to guide the reader step-by-step through the message. Grid is an invisible rhythm that allows us to sense regularity in what is seen, to help us anticipate what is bound to happen on the following pages... and ultimately to be surprised by what we eventually find there. Being one of visual grammar structures, a grid organizes visual vocabulary just as syntax organizes words in a sentence, similarly to how rhyming schemes generate patterns within poetry.

Contemporary grid stems enable our innate urge to organize things. The ancient Greeks used the golden ratio (1 : 1.618...) to design impressive temples such as the Parthenon. If the ratio of the sum of two quantities $M+N$ to the larger M is equal to the ratio of the larger M to the smaller N , then those three quantities are in the golden ratio. Artists, mathematicians and philosophers explored this ratio for centuries. In the 20th Century a more pragmatic approach emerged and Swiss/French architect Le Corbusier proposed the Modular—his own system of measurement and scale based on the proportions of human body.

Today, none of the rules of constructing the grid is regarded as universal, however there is a good practitioners' consensus to employ any favored grid and use it with persistence and consistency. An informed image-maker should therefore always decide prior to starting any design work what grid to use, how many identical modules should a column and a row have, what should be the size of a single module, how many lines of text to fit inside one module, how much space should be dedicated to margins (FIGURE 6). Once these decisions are made, it is crucial to adhere to them thoroughly, with no concession for exceptions or overriding initial guidelines. Consistency in using the selected grid results in quality work, thoughtful planning and order. Any deviation produces disorder and confusion.

Readers, who wish to further explore the topic of grids, grid templates and instructions on how to use them in practice, will be delighted to visit The Grid System website (www.thegridsystem.org). There one will find a range of useful resources, articles and tools, as well as an eye-opening simulation—make sure to press the “Show Grid” button in upper right corner of the web page.

VISUAL GRAMMAR: NEGATIVE SPACE

Negative space might seem a little bit like magic: it is invisible, it contains nothing, just void, but nevertheless it is still present, prompts associations, and fills our minds with visual stimuli and ideas. Negative space resides in close proximity to the subject of representation and influences it, often adding or shifting image meaning. In 20th Century avant-garde visual art negative space played major role being extensively studied by László Moholy-Nagy in his collage works, emerging in many paintings by Juan Miró, providing spatial context in Piet Mondrian's and Theo van Doesburg's compositions.

As an integral part of every visual composition, negative space, should never be considered as leftovers, mere by-product or waste. Quite the contrary—it should be harnessed and used in one's favor to reinforce the



FIGURE 6: Grid organizes text and images. Work-in-progress view (bottom spread, left page) reveals modular structure of the layout.

message an informed image-maker strives to communicate. If we consider drawing not as a process of adding color, but as a process of removing the white from paper, the concept of negative space becomes more defined and graspable. Because negative space can be created only indirectly as a quality of space around or between other objects, one needs to rely on the elements of visual vocabulary to produce it, as well as on one's keen eye to observe specific kinds of relationships those elements establish. Negative space between two parallel lines can transform in viewer's mind from space to invisible matter, if we narrow down the gap between those lines (FIGURE 7).

Very popular instances of exploiting the peculiar properties of negative space are figure-ground reversal images, e.g. the Rubin's vase (FIGURE 8). This example exploits the viewer's confusion and indecision toward interpreting what is the actual subject in the image—does

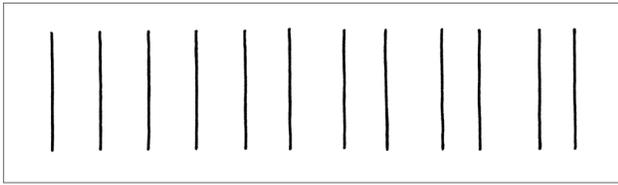


FIGURE 7: *Negative space. Invisible matter emerges from empty space as lines move closer to one another (redesigned and redrawn after Adrian Frutiger).*

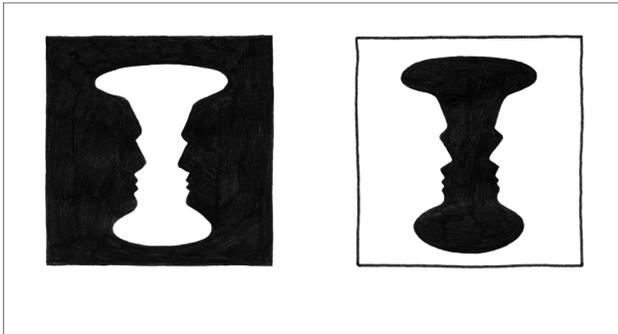


FIGURE 8: *Negative space. Figure-ground reversal images demonstrate how powerful a negative space effect can be.*

the contour outline a black silhouette of a vase? Or may be the negative space between two white profiles? An experienced image-maker will know how to handle negative space to channel its potential and avoid its traps.

VISUAL GRAMMAR: SYNTHESISED SEEING

Synthesized seeing relates to the overall balance of tones and shades observed in any image or text block. We squint our eyes to better see the whole by making it harder to notice specific details and particular features of an image. In an attempt to see the forest, we choose not to notice trees.

This simple trick—inspecting an image while squinting—provides an informed image-maker with a powerful tool of analyzing the distribution of shades and tints in a composition, as well as the relationships between them. It is also helpful when one looks for the visual keys presented in the image—viewer’s eyes will most likely notice and follow those parts of the image, where synthesized seeing reveals strongest contrasts. Finally, synthesized seeing gives the image-maker an opportunity to look at the image with a fresh, unbiased eye, which is always valuable when some visual distance is required to remain critical.

This technique of synthesized seeing is nothing new or controversial in the art world—at least not any more. It is owing to the 19th Century painters Jean-Baptiste Camille Corot and Édouard Manet, as well as the impres-

sionists who followed, that we now understand this anti-idealistic, very sober and critical approach towards an image: to represent only what is actually seen and not what is known to be in front of our eyes. Consider the painting by Claude-Oscar Monet titled “The Beach in Trouville” (1870), in which two ladies are portrayed sitting at the seaside. The observer looks against the sun, hence ladies’ faces are heavily shaded. Monet could not see their faces, so even though he knew they had faces and characteristic facial features (eye lids, eye brows, lips, noses, colored irises, etc.), he did not include that in the picture. Confident in only what he saw under those specific circumstances, he painted ladies’ portraits in a very synthesized manner.

Confident data explorers and visualizers shall keep in mind Manet’s, Corot’s and Monet’s lessons, and put themselves in their viewers’ position to seek balance in their works, as well as judge their image-making from an objective distance and through squinted eyes.

VISUAL GRAMMAR: TIME

Einstein showed that time is relative, but in our everyday experience of the passing of minutes, hours, days and years it changed very little. Time passes just as it passed last year, a hundred and a billion years ago. However—just like in Einstein’s physics—time for an image-maker is a malleable entity, yet another dimension that can be easily bent and manipulated with the use of simple visualization strategies, which we discuss below.

In showing time an image-maker employs sophisticated visual grammar structures, technical properties of selected media (from simple drawing to motion graphics, to interactive simulations) and most of all, external cultural connotations that allow the viewer to relate our real everyday experience of time to the visualized timescale.

How to slow down time? Whatever in human timescale takes just a split of a second (e.g.: a lightning) can be captured on photography and thus its lifespan extended even million fold. Looking at a photographed lightning is a gift of time—observing it live never allows enough time for noticing all the detailed shapes, random curves and edges it has. Ironically, lightning’s image can be stored today in the form of a digital bitmap on an electronic memory drive—maybe some of those electrons released from the skies are now engaged in storing a portrait of theirs on our hard drive (FIGURE 9)?

Is this process possible in reverse? How to speed up the passing of time? On two very simple images comparing the locations of African and South American continents in early Mesozoic era and today we can fast forward the



FIGURE 9: *Lightning captured in a photograph. A fraction of a second prolonged interminably.*

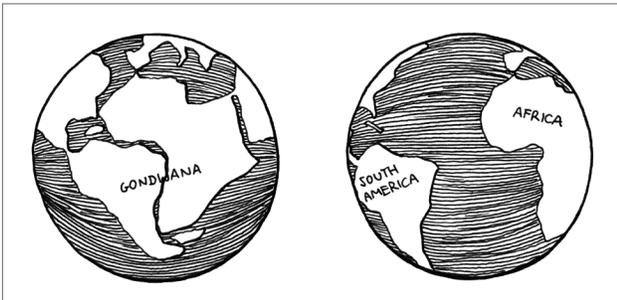


FIGURE 10: *Two images visualize continental drift. 250 million years observed in one second (redrawn after Antonio Snider-Pellegrini).*

continental drift that took place over 250 million years in a glimpse of an eye (FIGURE 10). Such visualization not only allows a skilled image-maker to communicate time to her/his audience. It also explains through illustrations of the results of a complex and invisible geological process. It argues by backing up a controversial theory with a convincing scenario. Finally, it fascinates, because it fuels one's imagination and interest in earth sciences.

SUMMARY

Nowadays visualization is one of the key ways, in which scientific discoveries and advances in collective understanding are made. Therefore, those scientists, researchers, data explorers, and analysts who rely in their everyday work on producing visualizations and generating images, should have some acquaintance with the most rudimentary ABC of good design practice.

Becoming knowledgeable in the basics of any practice-led discipline is never easy. That being the case, we have prepared a list of nine design commandments to conclude this article and hopefully stay with the reader for a while. Adhering to these commandments of good visual design practice will assist the reader with maintaining high quality of her/his own image-making:

1. *Make use of points, lines, areas, colors and typography to communicate information in a diverse and legible manner;*
2. *Use no more than 6 to 8 discrete hues in a single visualization;*
3. *Use up to 2 font forms (serif and sans-serif) and no more than 3 font sizes;*
4. *Having decided to use a grid, always respect it;*
5. *Harness negative space;*
6. *Less is more—remove redundancy to improve key message;*
7. *Place yourself in the position of your audience—learn to think like they do;*
8. *Always make good effort—otherwise your reader will need to;*
9. *Allow yourself enough time to produce high-quality visuals.*

FURTHER READING

The list below includes some of the most interesting and valuable positions, from which further information on visual language can be obtained. The first group of works (da Vinci, Strzemiński, Frutiger, Bertin, Arnheim, Tufte) focus specifically on visual language, a diversity of its forms and expressions. The authors critique visual structures and provide valuable guidance for implementation in one's own image-making practice. Unfortunately, the works of Frutiger and Strzemiński seem to be available only in their original languages (German and Polish respectively). The second group contains a selection of works (McCloud, Copley & Jansz, Hall, Maeda, Garland), which investigate with visual culture in a much broader sense. Here the reader will find information on semiotics, the workings of comics, information design. McCloud and Garland also provide a detailed account of the design process, which can serve as inspiration for curious image-makers.

"A Treatise on Painting" by Leonardo da Vinci;

"Teoria Widzenia" by Władysław Strzemiński;

"Der Mensch und seine Zeichen" by Adrian Frutiger;

"Semiology of Graphics" by Jacques Bertin;

"Visual Thinking" by Rudolf Arnheim;

"The Visual Display of Quantitative Information"
by Edward R. Tufte;

"Envisioning Information" by Edward R. Tufte;

"Visual Explanations" by Edward R. Tufte;

"Beautiful Evidence" by Edward R. Tufte.

"Understanding Comics" by Scott McCloud;

"Introducing: Semiotics" by Paul Copley
and Litza Jansz;

"This Means This, This Means That" by Sean Hall;

"The Laws of Simplicity" by John Maeda;

"Mr Beck's Underground Map" by Ken Garland.

BIOGRAPHY

Marek Kultys, MA is a very interdisciplinary communication designer, design consultant and an independent researcher based in London, UK. He works in the field of visual communication, information design and visualizing invisible structures. While actively collaborating with scientists, information mappers, educators, and other designers, Marek also pursues his own research into the interplay between design and sciences. Values design that makes people think, understand and act.

Marek holds M.A. in Communication Design from Central Saint Martins College of Art and Design in London, having previously studied design in Warsaw and Zürich. He exhibits, speaks and teaches internationally.

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