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Information Design 4

Graphic Design

Revised edition 2015

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Institute for infology

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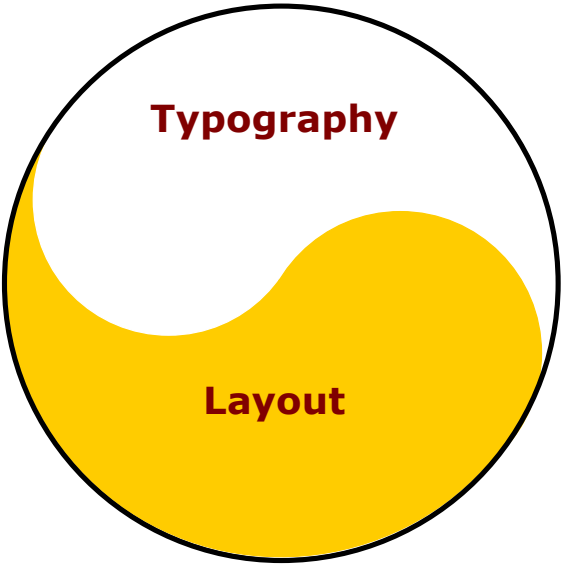

Rune Pettersson * Institute for infology

Information Design 4–Graphic Design

Yin and yang, or yin-yang, is a concept used in Chinese philosophy to describe how seemingly opposite forces are interconnected and interdependent, and how they give rise to each other. Many natural dualities, such as life and death, light and dark, are thought of as physical manifestations of the concept. Yin and yang can also be thought of as complementary forces interacting to form a dynamic system in which the whole is greater than the parts. In information design, theory and practice is an example where *the whole is greater than the parts*.

In this book drawings and photos are my own, unless other information.

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Preface

Information design is a multi-disciplinary, multi-dimensional, and worldwide consideration with influences from areas such as language, art and aesthetics, information, communication, behaviour and cognition, business and law, as well as media production technologies.

Since my retirement I have edited and revised sections of my earlier books, conference papers and reports about information design, message design, visual communication and visual literacy. The result is this series of six books:

Information Design 1–Message Design
Information Design 2–Text Design
Information Design 3–Image Design
Information Design 4–Graphic Design
Information Design 5–Cognition
Information Design 6–Predecessors & Pioneers

These books include definitions, selected results from research, theoretical considerations, as well as practical guidelines for message design. The intended reader is especially interested in research and theory related to message design, and the design of information materials and information sets.

Tullinge, Sweden
Rune Pettersson, Ph.D.
Retired Professor of Information Design

Contents

Organized structure

Although we may not think about it, the practice of graphic design is as old as recorded history. We see the results of graphic design every day in books, magazines, packages, papers, posters, symbols, and many other products.

Graphic design

A generally accepted view is that graphic design may be described as the art and craft of bringing a functional, aesthetic, and organized structure to different kinds of texts and illustrations. Graphic design is a *process* (verb) as well as a *result* (noun) of that process. Traditional graphic design is a kind of "all purpose-design" used in the production of various media. Modern visual graphic design has its roots in the rational, functional aesthetics that evolved in traditional graphic design over the centuries for the print media, and are now used in industrial design, as well as in architecture.

Purpose for graphic design

The purpose of work with graphic design is to find a *suitable presentation of the message* with respect to the intended receiver, medium, and economical situation. A well-designed book appears as a "unified whole." All design elements serve to enhance the content.

Melin (1999, 2011) found that it is more likely that graphically complex texts will be read than "plain" texts. And it takes less time to read a graphically complex text than a "plain" text. Readers often react in a positive way to texts with good typography and good illustrations. The overall visual look shapes

users' perceptions of consistency and user satisfaction in browsing tasks (Ozok & Salvendy, 2000).

Within a given area, such as a page in a book, a computer screen, or a projected image, we may alter the presentation of text (headings, running text, captions, lists), pictures, tables, and the background (margins, ornaments, page number, space).

When text and graphics are organised into meaningful semantic clusters, this makes it easier for readers to chunk the content (Kahn, Tan & Beaton, 1990). Visual grouping of text enables readers get a sense of the overall structure (Tullis, 1997), and help readers remember content (Niemela & Saarinen, 2000). How the content is grouped may influence the readers' first impressions of the content (Lindgaard et al., 2006). Readers will better remember the content and make fewer errors. Careful integration of words and pictures engage people more effectively than words or pictures alone (Sadoski & Paivio, 2001).

Producers of information and learning materials can facilitate communication, and the learning processes of the readers. Complicated language, in both texts and pictures, will impair the understanding of the message. Active voice, clarity, comprehensibility, consistency, legibility, precision, readability, reading value, simplicity, and structure are the key concepts in information design. Hiebert (1998) saw graphic design as interface design (p. 9):

> In the largest sense, all graphic design serves as an interface. It is the filter that facilitates communication between users and products, places, processes, information, and services. This interface may have the purpose of description or persuasion. It may be in a process of one-way presenta-

> tion or two-way discourse (interactive). It has a functional rather than a decorative purpose.

The role of graphic design is functional. According to Bull (1999) there are currently many debates as to what the role of a designer is. Terms like "Visual Communicator" and "Information Architect" have arose. Many of these debates have grown out of many designers' misuse of technology and the computer. Bull concluded (p. 54):

> In our fast-paced, drive-thru oriented society, the graphic design community often suffers from the public perception of what I have coined the 'Kinko's Mentality'. This is where anyone with a computer is legitimized as a designer and solutions to your problem can be given form based on a solution to another problem. And of course, it all perpetuates the idea of the designer as just someone who just dresses things up.

The study of rational, functional aesthetics, as well as effective and efficient layouts for all media makes graphic design interesting for information design scholars. Graphic design is a tool with which we can manipulate the raw materials – words in different typefaces, sizes, styles, empty space, illustrations, colour, paper and ink, and the final number of pages – to achieve the best possible communications between people.

Waller (1980) provided a list of codifying rules for graphic language and functions of the typographic organization of text in a book. Waller discussed two main categories (I) Rhetorical functions, and (II) Access functions (p. 246):

I. Rhetorical functions

1. About the argument.

   - Summarization (title, summary).
   - Introduction (foreword, preface, introduction).
2. Within the argument
   - Emphasis (underlining, italics, etc.).
   - Transition (headings, space, etc.).
   - Bifurcation (alternative options, parallel texts, interpolation sections).
3. Extra to the argument
   - Substantiation (footnotes, appendices, references).
   - Addenda (apologia, acknowledgements, etc.).

II. Access functions

4. About the book.
   - Overviews (contents list, abstract).
   - Definitives (glossary, index).
   - Identifiers (title, author, style).
5. Within the book.
   - Locators (topical headings, typographic signalling).
   - Descriptors (functional headings, captions).
6. Extra to the book.
   - Study guidance (recommended reading, exercises).

Graphic design objectives

Any graphical message should be *legible* for the intended audience. (It should also be *readable*, and well *worth reading*.) In graphic design the main objective is to provide functional, aesthetic, and organised structure to all kinds of information sets. The intended individual information interpreters might be seen as “readers.” They may develop new views, relaxation, emotions, awareness, attention, and understanding. In the writing of *graphic design objectives* it may be an advantage to use verbs

like *find, identify, read,* and *recognise*. These verbs all denote observable behaviour. A few examples of performance objectives in graphic design may be:

- For a table: 100% of the users should be able to find the time for departure of the train to x.
- For a package: 100% of the buyers should be able to read the text on the package without any difficulty.
- For a non-fiction book: 100% of the readers should be able to read the text in the book without any difficulty.
- For a logotype: 60% of the readers should be able to identify a new logotype within six weeks.

Of course we have to decide the actual numbers, with respect to percent and allowed time, in each specific case.

Graphic design processes

Around 1850 the sculptor Horatio Greenough wrote, “form follows function”. The architect Louis Sullivan made this phrase famous in 1896. However, Mijksenaar and Westendorp (1999, p. 34) concluded that architects, engineers and designers rarely follow this rule. Many theories of design processes may have been devised with three-dimensional products in mind. However Adams (1999, p. 4) argued that there is no reason not to apply these design processes to their two-dimensional relatives.

Some examples of design processes

Several processes for problem solving are related to design. For example Shadrin (1992:29) discussed problem solving based on the following seven steps or “constants” as a system for problem solving:

- Design activity (What is the problem?)

- Analysis (What is the purpose and function of the design?)
- Historical reference (How was it done before?)
- Visual communication (How can I communicate my idea?)
- Skills (What skills do I need for this design?)
- Technology (How will the design or product be made?)
- Evaluation (Is this the best solution I can come up with?)

Roozenburg and Eekels (1995) presented a design process with error elimination step by step. They noted the following steps:

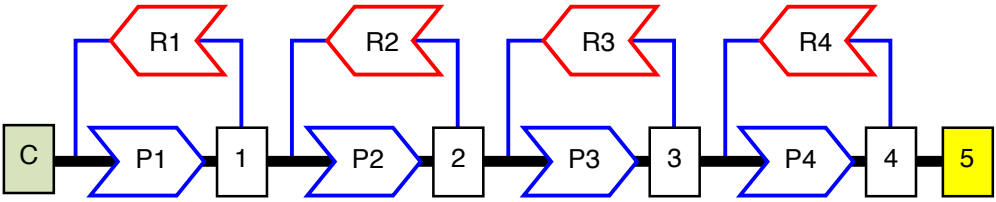
- Problem definition
- Analysis
- Criteria
- Synthesis
- Preliminary design
- Simulation
- Expected properties
- Evaluation (based on Criteria)
- Value of the design
- Decision (feedback to Synthesis and Analysis)
- Acceptable design

Roozenburg and Eekels stress the development of criteria to be used in judging the success of a resulting design. The functioning of a potential design solution is assessed in a simulation. The observed properties of the assessed solution are used to infer the properties that we may expect from the final product. Bull (1999) noted the following steps in a graphic design process (p. 53):

- Problem definition.
- Research.
- Conceptualization.

- Prototyping.
- Testing.
- Implementation.
- Documentation.

Adams (1999, p. 4) described how the writer and the designer are working together in some manner using a mental model of the user and of the way in which the communication will be used. Within this mental model words, verbal structures, possibly illustrative pictures, and indeed the whole design concept are constructed. When the user approaches an information product, he or she brings a history of interaction with that type of information product. The user will be of a social and cultural background, will have a certain education and ability level and will have a certain motivation regarding the use of the product.



The creative message and information design processes include four different production (P) and review activities (R). The production activities are analysis and production (P1) of synopsis (1), production (P2) of draft (2), production (P3) of script (3), and production (P4) of original 4) and master (5). C = commission.

My own "message design and information design model" includes the following four process activities: analysis and synopsis, production of draft, production of script, and production

of original and master. Each activity includes a design sub-process, activity documentation, and a review process. Main message design tools will include text (printed and spoken), symbols, pictures (drawings and photos), typography and lay-out, light and light effects, sound and sound effects.

Often a team of people with skills in the different areas are working together in a *design team*. The task may be too overwhelming for a single person.

(See the book *Information Design 1–Message Design*.)

Reduction

According to Mullet and Sano (1995, p. 38) the most fundamental design technique is reduction. Wherever possible the designer should remove insignificant elements in layout, pictures, and texts in order for significant design elements to be clearly noticed. An elegant design must be reduced to its essential elements and each element reduced to its essential form. As an example a good symbol for a sign is simple and clear. It has an optimal colour, dimension, form, and size (Barlow & Wogalter, 1991; Dewar, 1999; Wogalter, 1999).

A text on a poster, and on a screen, shall be bold enough (Mayer, 1993; Ormrod, 1989; Pettersson, 1993; Wileman, 1993), and large enough (Ormrod, 1989; Pettersson, 1993; Wileman, 1993). Too small or too large lettering will impair reading. The text shall also have good readability (e.g. Kirkman, 2003, 2005; Klare, 1985; Lipton, 2007; Mackiewicz, 2004; Pettersson, 1989; Young, 1989).

It is generally accepted that good design is simple, bold, and direct. It ensures that significant design elements will be noticed by removing insignificant elements wherever possible. Most people read instructional materials selectively. Readers

rarely, if ever, begin at the beginning and read straight through to the end. Usually we use a combination of browsing, reading headings, looking at illustrations and captions, reading certain parts carefully, skimming others, and avoiding some parts completely.

Information layout

Information layout differs from a *decoration layout,* in which purely aesthetic aspects dominate. When illustrations in textbooks are not relevant to the prose contents, they do not facilitate understanding. On the contrary, illustrations can actually have a negative effect on reading comprehension and prose learning. Therefore illustrations should not be used only for decoration in information and learning materials. (See the section *Image functions in teaching and learning* in the book *Information Design 3–Image Design.*)

Today many visuals are too complicated and would communicate better if designers valued simplicity over decoration. Aesthetically pleasing visuals may deceive the learners about their instructional values. There are many situations where colour and typographic elements can be used for decoration. However, a decorative use of colour or typography should never be mixed with the intended use to provide clear structure, simplicity and hierarchy. It must always be very clear and easy for the receiver to understand when colour and typography are used for decoration and when the use is meant to have some cognitive importance.

History of graphic design

People have been designing, planning and executing information sets, information materials, and messages in all times. Mullet and Sano (1995, p. 9) noted that whereas *art* strives to express fundamental ideas and perspectives on the human condition, *design* is concerned with finding the representation best suited to the communication of specific information.

The Egyptians were the first culture to produce illustrated manuscripts and wall decorations that combined their writing system with illustrations. In the fifth century, the Greeks introduced the concept of symmetry. This was based on their observations about the natural world. Later, Roman artists developed symmetric arrangements of letters and graphic elements. For centuries monks produced hand-drawn manuscripts in their monasteries. They paid careful attention to the selection and placement of each graphic element, and they tried to maintain a consistent style throughout every single work.

Step by step

With the invention of the printing press the publisher or art director employed assistants to design typefaces for good legibility and high aesthetic value (Meggs, 2005). At this point, more care could be given to typography, illustrations and graphic design. Book pages were often decorated with borders and various kinds of ornaments as natural parts of the final design. Artistic and aesthetic values of each historical period have been dominating in traditional graphic design.

Since the time of Gutenberg graphic design has developed as new printing devices were invented. For centuries words and pictures were separated by less developed technology. There

was no method to print text and pictures together with good quality until the lithographic process was invented.

Originally all lithographs were printed from a flat, lithographic limestone on a flatbed press. The image and the text are drawn on the flat surface of the stone with a greasy crayon, an oily wash, or with India ink. After a chemical treatment the parts of the stone without the image and text elements are susceptible to water. The printing ink is transferred to the paper from the surface with the image and the text. Lithography was invented in 1798 and has been used for printing of lithographic art, but also posters, placards, cards, advertisements, etc.

By 1834 specially treated zinc plates began to replace the heavy stones. From 1860 to 1900, lithography was commonly used for art reproductions, posters, greeting cards, and business cards. The use of photomechanical metal plates in the early 1900s made the technique of hand transferring from stones obsolete. Lithography expanded the range of graphic design.

With the invention of the half-tone screen it was possible to print photographs as half-tone pictures. This information is converted to the raster-dots that are employed in the printing of the picture. The printed dots vary in size from nothing or a very small dot to gradually increasing dot-sizes. Smaller dots give the impression of light grey areas in the image, and larger dots give the impression of darker tones. The number of raster-dots defines the quality of the final printed image.

The first colour photographs were reproduced in 1881. Advances in photoengraving and halftone techniques allowed the regular use of photographs in print media by World War I. Because of the modern computer the methods for presenting photographs are changing radically. Halftone screens can now

be simulated with computer programmes that sidestep the entire photoengraving process.

Today the graphic designer has even more freedom than the monks during the Middle Ages. Now, it is possible to combine words and pictures at will, in effective and efficient layouts for all media. Modern visual graphic design has its roots in the rational, functional aesthetics that evolved in traditional graphic design over the centuries for the print media, and in industrial design, as well as architecture.

According to Baggerman (2000, p. 9) possibly the most important thing to keep in mind is that there's no recipe that's going to make your design appropriate for all applications and users. It helps to think of any designed piece as an interface, be it a book, shampoo bottle, retail store, or Web site.

Modern graphic design

Today graphic designers work in "persuasion design," as well as in "instruction design," and in "information design." Graphic design is a natural part of these design areas. Graphic designers are responsible for typography and layout in information and learning sets. The graphic designers may also produce the final master for printing.

At the beginning of the twentieth century avant-garde designers, from the modern art movement, found inspiration from efficient, functional, interesting, and powerful new machinery. The avant-garde designers used visual forms that were fitting for the new and modern world. They explored asymmetrical layout, functionalism, geometric typefaces, hierarchy, minimalism, serial design, universality, and white "empty" space. Modern graphic design emerged out of the modern art movement.

The history of graphic design reveals that the manipulation of visual structure has always been fundamental to our thinking about how communication works (Davis, 2012, p. 22). During several decades graphic design was gradually consolidated into a design profession. The theoretical base for graphic design was developed from avant-garde movements such as the Russian artistic and architectural philosophy *Constructivism*, the Dutch artistic movement *de Stijl*, and the German school *Bauhaus* that combined crafts and fine arts. Bauhaus was famous for the new approach to design. After World War II many art schools worked with influences from these early movements and practices. In the middle of the twentieth century graphic design became a profession in its own right.

Design scholars like György Kepes (1944), Rudolf Arnheim (1954), and Donis Dondis (1973) wrote textbooks with design principles based on abstract painting and Gestalt psychology. All of them have a focus on *visual perception*. For these authors design is an abstract and formal activity. A theory of design that isolates visual perception from linguistic interpretation encourages indifference to cultural meaning (Lupton & Miller, 1999, p. 62).

Kepes (1944) argued that visual communication is universal and international. Visual communication knows no limits of tongue, vocabulary, or grammar. This book was used as a college textbook, and had thirteen printings, in four languages.

Arnheim (1954) described picture perception as a matter of responding to basic forms such as gestalt laws. An important point is that visual perception includes the same behaviours that we commonly consider only as matters of cognition or thinking.

Dondis (1973) discussed the use of several pairs of oppositions as techniques for visual communication. A few examples are: Balance – Instability, Simplicity – Complexity, and Transparency – Opacity. These oppositions present the graphic designer with effective means of making expressive visual communication.

From the 1950s/1960s graphic designers abandoned the old avant-garde ideals, and used formal methods. They worked with restricted typography in layouts based on strict grids. The new *International Typographical Style*, also known as the *Swiss Style*, favoured values of asymmetric layouts, cleanliness, legibility, neutrality, objectivity, photographs rather than drawings, rationality, and sans-serif typefaces.

According to Horn (1999, p. 25–26) information design is experiencing a variety of tensions. Graphic designers "learn in art school to worship the gods of Style and Fashion, Novelty, Impact and Self-expression." Technical communication people "worship the gods of Clarity, Precision, Legibility, Comprehensibility, and (often) Simplicity."

In the book *"Graphic design theory Readings from the field"* (Armstrong, 2009) twenty-four graphic designers explores the aesthetic and social purposes of design practice. These authors present what they think about what they experience is going on in the world of design discourse. Topics range from Bauhaus, over postmodernism and social responsibility, to Internet.

Armstrong (2009, p. 97) noted that digital technology fundamentally transformed graphic design "as one millennium ended and another began." The old avant-garde issues of authorship, social responsibility, and universality were reborn within society's newly decentralized network structure. In-

dustry-standard software and restrictive web protocols formed a new universal graphic language, while the subjective shift expressed in New Wave and postmodern design instilled a revived sense of agency among designers.

Providing clarity, providing emphasis, and *providing unity* are three of the *Functional principles* in information design (Pettersson, 2010). Information materials should be as clear, simple, unambiguous and transparent as possible. We should avoid unusual typefaces, as well as fonts that are too small or too large. Typeface and font size must be adapted to meet the limitations of the medium, and the technical production. The most important elements in an information material may be emphasized to enhance attention and perception. Emphasis may be used to *attract*, *direct* and *keep* attention. Information materials should have an "overall coherence and togetherness." Inconsistencies in information materials may confuse the receivers.

Research-based design

According to Lester (1995, p. 168) the designer W. A. Dwiggins was the first to use the term *graphic design*. This was in 1922. During his career he worked on more than 300 book designs. Although we may not think about it, the practice of graphic design is as old as recorded history, and we see the results of graphic design every day. We see books, cards, exhibitions, magazines, newsletters, packages, papers, posters, signs, tickets, and many other products. Often graphic design is thought of with regard only to the print medium, but it is also used in several other media. Hurlburt (1981, p. 22) defined graphic design in the following way: "Graphic design is an umbrella term that covers a broad range of printed and projected images. Its

three principal functions are to persuade, to identify, and to inform."

Advertising is generally regarded as the means for persuasion, although at times its purpose may also be to identify or to inform. Corporate identification focus on identity, but corporate literature will often inform, and corporate advertising may also have a persuasive purpose. In package design the function is also to protect the content in the package.

Hightower (1989, p. 7) noted that graphic design is a ubiquitous presence in our daily lives that can engage and inform us or simply add to the visual morass of contemporary culture. Important and unimportant messages are graphically communicated throughout the day.

According to Friedman (1989, p. 10) the taint of commerce has relegated graphic design to the status of "second class" discipline in the academic realm. In order to better this low status, the discipline needs to adopt more theory. However, at present there seems to be few theoretical foundations for graphic design. Much of the work is apparently based on intuition, and some on fundamental principles.

According to Zwaga, Boersma and Hoonhout (1999, p. xix) researchers active in a field of applied behavioural science implicitly expect that designers concerned with the usability of their products will eagerly pick up the fruits of scientific investigation and use them in their designs.

Many guideline documents have been published over the years. However, to the disappointment of ergonomists and behavioural scientists designers do not read their handbooks, or their scientific journals, and they are not prepared to apply experimental data to their work. Often designers are not even aware that this guideline information exists. The efforts were

wasted because they did not understand what designing was all about. However, Dillon (1994) found that designers seek further guidelines and usability standards, and that they are prepared to apply guideline information.

Adams (1999, p. 19) concluded that designing of good information-giving material is a difficult task, but it is one that can be assisted greatly by appropriate usability testing. Wogalter (1999) noted that if the testing shows that a number of people do not understand the message, or worse, misunderstand it, then the material must be redesigned and tested again – until it is understood by the intended audience. Users of information products still largely blame themselves when faced with poor design of any kind. Thus a push for research-based information design must come from the information designers. In each case members of the specific user group may be invited to evaluate preliminary texts and sketches for drawings and photographs.

Aesthetic principles

Aesthetics is usually regarded as a branch of philosophy, along with epistemology, ethics, logic, and metaphysics. It is the youngest branch of philosophy with its own name. Aesthetics implies a hierarchical judgement in which the elements of any compositions, and their organisations, are considered more or less appealing to the senses by virtue of their ability to create higher emotional, intellectual, or moral appreciations in people. The group "*Aesthetic principles*" is one of the four groups of message design principles. This section includes *Aesthetic proportion principle*, and *Harmony principle*.

Aesthetic proportion principle

Basically proportion is a mathematical concept. However, the concept *aesthetic proportion principle* is very much a subjective concept. It is related to the appropriate and pleasing relations between elements in information and learning materials. Aesthetic proportion deals with aesthetic aspects of information sets.

We may all have different ideas of what we find beautiful and rewarding, and what we find boring, disturbing, distracting or ugly. When a design is *out of proportion* it is lacking appropriate relations. It may be disproportionate, exaggerated or overemphasized. Aesthetic designs are perceived as easier to use than less-aesthetic designs (Lidwell et al., 2010, p. 20). The information designer may:

- Find out receiver preferences of aesthetic proportions.
- Be careful using proportions according to the "golden section."

- Never mix a decorative use of colour with cognitive importance.

This section includes the following two sub-sections 1) fine art, and 2) information aesthetics.

Fine art

Throughout history all cultures have produced musical, verbal as well as visual art. Fine art is usually assumed to mean the visual arts, like architecture, painting, and sculpture. The impulse to create, to recognise and to generate order, seems to be universal.

Different reasons

One of the earliest human artistic acts was to spend more time shaping tools than was functionally necessary. Palaeolithic Neanderthal man carefully decorated their spearheads. Some theorists argue that the origin of human creativity can be found in these early crafts of making tools and weapons.

Throughout history people have produced art for different reasons, such as religious devotions, special commemorations, adornments, and also for personal expressions. Art has also been created on many scales, from huge buildings and monuments, large murals and paintings to small jewellery and miniature paintings. The broadest generalisation may be that the visual arts are spatial rather than temporal. Music and literature must be experienced serially in time. The visual arts must be experienced in space. Space is an illusion in painting. Here an indication of three dimensions in two dimensions is rendered by conventions.

However, the conventions vary during different periods and in different places. In many situations it is not at all possible to

"understand the meaning of fine art." To some degree, the physical materials that artists use will influence the properties of the resulting artwork. As an example, a fresco painting on a wall has visual properties that are different from the properties of an oil painting on canvas.

Divine proportion

In fine art classical formats are based on the *divine proportion* or the principle of the *golden ratio*. This is an irrational number is calculated from a line that is divided into two segments in a certain way. The ratio of a line (a+b) to the larger segment (a) is the same as the larger segment (a) is to the shorter segment (b). Thus (a+b)/a = a/b (Livio, 2002, p. 3).

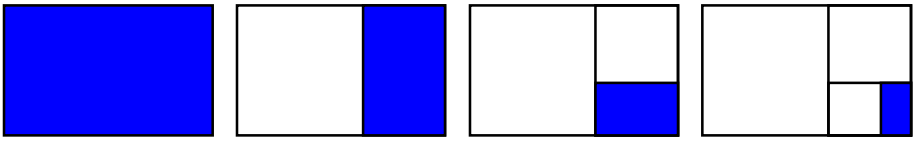
According to the Divine Proportion (a+b) is to a as a to b.

This mathematical relationship forms an irrational number, i.e. a number that never ends. Around 300 B.C. Euclid of Alexandria, in Egypt, provided the first mathematical definition of the *golden ratio* (Livio, 2002, p. 3). (With ten decimals the *golden quota* is 1.6180339887.) In the early 20th century the American mathematician Mark Barr named this irrational number "phi" in honour of the Greek Sculptor Phidias (Livio, 2002, p. 5). Historians believe that Phidias lived circa 490–430 B.C.

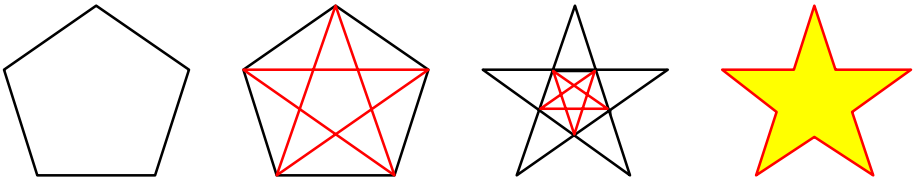
The principle of the golden ratio is comparable to the well-known "Fibonacci numbers": 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, and so forth. In this sequence any term after the first two is the sum of the previous two terms. This property is a close ap-

proximation of the golden quota (8/5 = 1.6). A *golden rectangle* therefore has sides of approximately the same proportions, 8/5. Any such rectangle is enlarged by being multiplied by 1.62, and reduced by being multiplied by 0.62.

Traditionally, the golden rectangle is considered aesthetic in the western world (Arnheim, 1974; Berndal & Frigyes, 1990; Bringhurst, 2004; Koblanck, 1999; Moriarty, 1991; Pettersson, 2002). For 2,500 years the principle of the golden ratio has been used in art and architecture to create harmonious proportions. The golden ratio is a well-known standard format for fine art, flags, symbols and more. During the nineteenth century the golden ratio was much used in painting academies.



When we divide a rectangle according to the golden ratio by adding a square, the rest of the original rectangle (the blue surface) gets the golden ratio. In theory we can repeat this process forever; in reality though, there are always physical limits to this.



When diagonal lines are drawn in a pentagon, several examples of the golden ratio emerge. At the same time "phi" is the property between the diagonal and one side in the pentagon. The five-point star is used in many ways.

The *aesthetic value* of a message is how the intended receivers perceive it with respect to its beauty. Material with a (sufficiently) pleasing form has greater potential for conveying a particular message than does non-aesthetic material. With the invention of the printing press the publisher, or the art director, employed assistants to create typefaces for good legibility and high aesthetic value. In this new situation, more care could be given to typography, illustrations, and layout. As previously noted book pages were often decorated with borders and various kinds of ornaments as natural parts of the final design. Artistic and aesthetic values of each historical period have been dominating in traditional graphic design. Since the time of Gutenberg the art and practice of graphic design has developed step by step, as new printing devices were invented and introduced.

Aesthetically pleasing visuals may not be of great instructional value. "The value of different types of visual illustrations is not a valid assessment of instructional effectiveness that is, aesthetically pleasing visuals may not be of great instructional value" (Dwyer & Dwyer, 1989, p. 122). It is, however, possible that aesthetically pleasing information material will be noticed and used better than material without any aesthetic qualities (Holmes, 1993). Malamed (2009, p. 203) noted that when viewers look at both pleasant and unpleasant pictures, they consistently demonstrate an emotional reaction indicated by pronounced brain activity that does not occur when they look at neutral pictures.

Information aesthetics

Norman (2002) argued that *visual attractiveness* is important for the cognitive domain since the affective domain is highly related to human cogitation.

Lidwell et al. (2010, p. 20) found that aesthetic designs are perceived as easier to use than less-aesthetic designs. Information aesthetics deal with aesthetic aspects of information sets. In some situations art may be used for information, and information may in some situations be classified as art. A good example of this is the brightly coloured posters designed by artists like Jules Chéret (1836-1932), and Henri de Toulouse-Lautrec (1864-1901).

(See the book *Information Design 6–Predecessors & Pioneers*.)

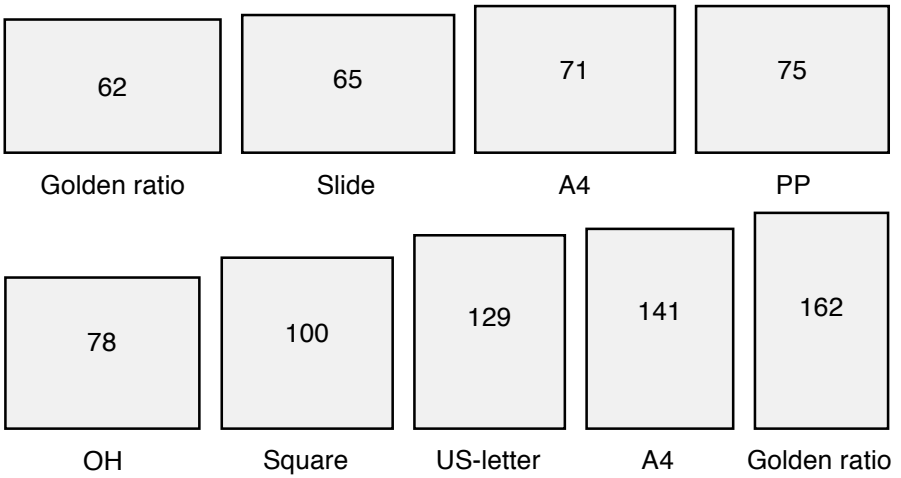
Chéret is often called both "the father of modern advertising" and "the father of the poster". He produced about 1,200 posters. Toulouse-Lautrec is often called "the king of posters". A register of his complete works shows in all 350 lithographs, of which about 30 are posters. The 27-year-old Toulouse-Lautrec became famous over a night, when his poster "Moulin Rouge: La Goulue" was put on walls and advertising pillars all over Paris in October, 1891.Toulouse-Lautrec revolutionized the art of posters and gave the commercial poster the status as an independent art form. Jules Chéret, Henri de Toulouse-Lautrec and many other artists who worked with commercial posters did not follow the old principle of the Golden Ratio.

A format index

It is difficult to compare pages and pictures, especially in different media and in different sizes. To objectively compare formats of pages, papers, and different kinds of images and pictures I

have developed a simple *format index*. It is calculated as the height/width x 100. Regardless of the size of the individual artefacts all wide formats get index numbers below 100. All square formats get index 100, and all vertical formats get index values over 100.

The format index can be used to compare pages and sheets of paper (as a *page format index,* or a *paper format index*). When we use standard A-series papers horizontally they get index 71. When we use the same papers vertically they get index 141. When we use US-letter papers horizontally they get index 77. When we use these papers vertically they get index 129.



This illustration shows some index values.

The format index can be used to compare pictures and projected images (as a *picture format index*). The horizontal golden ratio format has index 62, and the vertical golden ratio format has 162. A projected slide has index 65, a PP 75, and an OH 78. The image area on a horizontally held iPad Air2 has index 75, and when it is held vertically the index is 133.

Study of book pages

For many years designers and fine artists have been using, and are still using, the proportions of the golden ratio in their work. It can be used in paintings, page formats, or picture formats in print products, e.g. in books. Furthermore, handbooks in typography and graphic design recommend the use of the golden ratio. In her book *Creative Advertising*, Moriarty (1991, p. 237) noted that:

> Most quality books and magazines use page sizes that are close to a 3:5 ratio. The amount of type on the page relative to the overall page size is roughly 3:5. The proportions of the page margins to the text area are also 3:5.

The Penguin publishing house has used the page format 111x180 mm (3:4.9) for more than half a century (Bringhurst, 2004, p. 157).

In order to study if, or and to what degree, the golden ratio is a good principle for design of harmonious book pages we carried out a study with 126 university students from Sweden and 44 from USA (Pettersson & Strand, 2006). Subjects were asked to fold a white paper, size 45x45 cm, to a book page that they felt was the most harmonious. There was no time limit.

Results showed that there is a large variety in the values of what a harmonious book page is. *On average the most harmonious book page is 22.7 cm high and 16.6 cm wide.* The mean area is 382 cm^2. Very few subjects created book pages according to the principle of the golden ratio. There was no notable difference between the perceptions of women when it comes to a harmonious format on a book page. In this study the mean format index was 137 for men and 135 for women. These format indexes are close to regular paper, and far away from the golden

ratio. The study showed no significant difference in values of subjects in the two countries. It was concluded that the golden ratio is *not a good principle* when it comes to design of book pages.

Study of headings

According to Berndal and Frigyes (1990) the golden ratio has been used in the past to estimate suitable levels for headlines in a document. The size of body type is multiplied with 1.62, and then rounded off. If the body type is ten Didot points (=10.7 pica points), and there are four levels for headlines in the document, the following sizes are adequate: 10, 16, 26 and 42 Didot points.

However, the use of the golden ratio in art and design seem to be based on tradition rather than on facts. In one experiment I studied how subjects perceived different headings. In the fall of 2002, students at Mälardalen University in Sweden were asked to carefully study and then rank six variants of page layouts (Pettersson, 2003, p. 45). Subjects were asked to carefully study the six variations and rank them. There is a relatively large spread in their perceptions. All the six layout variants were ranked according to the alternative "best," or "second best" by at least one person. Taken all together two clear groups emerge, one group that is considered "better," and one group that is considered "not as good."

To the "better group" belongs: classic book typography (average ranking 2.5), the x-law with normal body type (average ranking 2.6) and my model for study books (average ranking 2.8). These three variants are considered clearly better than the ones that belong to the "not as good" group.

The “not as good” group consists of the X-law with bold text type (average ranking 3.8), and the two layout variants that are based on the principle of the golden ratio (average ranking 4.6; and 4.7). The principle of the golden ratio apparently gave too much difference between the type sizes. Also note that the two variants with bold headlines belong to the ”not as good” group.

Harmony principle

The *harmony principle* is one of the two aesthetic principles in information design (Pettersson, 2010). Harmony describes the effect of the pleasing interaction, and combination of elements to form a consistent and orderly whole of all elements in a design. Certain design elements look good when they are placed together and when they interact in a final design. Other design elements may look ugly and be distracting. Harmony in design can be said to be a pleasing arrangement and combination of elements to form a consistent and orderly whole. We need to find a good vertical as well as a good horizontal balance on a page.

Kandinsky wrote (1912/1977 p. 47): “never has there been a time when it was more difficult than it is today to formulate a complete theory, ...” Here Kandinsky was referring to a theory of harmony and a firm artistic basis. This is still difficult, and not only with reference to art, beauty and harmony-but also with reference to design. The information designer should:

- Develop standard templates for graphic design.
- Use standard templates for graphic design.
- Find balance between the design elements.

The term *harmony* may be used in all design disciplines to mean that the design decisions, and the design elements fit to-

gether. Graphic designers and information designers often use the term harmony in discussions on typography and layout. There is harmony in information material when all design elements fit well together and form harmonious relationships. Harmony is often closely related to *unity* (Wileman, 1993). *Balance* and *contrast* are important aspects of harmony (Mullet & Sano, 1995).

This section includes three sub-sections: 1) dichotomy, 2) harmony in typography, and 3) harmony in colour.

Dichotomy

In the Greek mythology there is a perpetual struggle between two sets of opposing forces or ideals, the *Apollonian and Dionysian dichotomy*. Apollo and Dionysus were both sons of Zeus. Apollo was the god of common sense, distance, dreams, healing, reason, self-control, and the sun. Dionysus was the god of wine, god of emotion, excess, ecstasy, passion, rage, and wildness. The Apollonian ideal celebrates human creativity through reason and logical thinking. The Dionysian ideal is based on chaos and appeals to the emotions and instincts.

The Apollonian and Dionysian philosophical dichotomy is commonly associated with the German philosopher Friedrich Nietzsche (1844-1900). The visual arts share the same features as Apollon, while music is the essence of Dionysus. Paglia (1990) used this dichotomy as the basis in her *theory of art and culture*. The Apollonian is light and structured, and associated with males. The Dionysian is dark and chthonic, dwelling within or under the earth, and associated with females.

Harmony in typography

Harmony in typography will be achieved when there is good relationship between the individual elements in the design and the "wholeness". A balanced typography gives an impression of quality and credibility.

Contrast is the difference between the brightest and the dimmest parts of a picture or of a text. Regardless of the colour and colour-contrast effects contrast should be clear and differentiate image elements from one another.

Contrast in typography may be achieved by using different fonts, styles, sizes and colours. Improper contrast is far too common. It is quite often a more or less even shade of grey or chromatic colours. Different hues may have the same value, and as a result almost no contrast. Another common problem is the use of too small symbols and small type. Text must be large enough. The difference in resolution in different media is very important. We tend to order impressions that form natural opposites, thereby reinforcing one another, in groups.

Balance is the sum of all the elements, the verticals and horizontals, the darks and lights that make up the design. Man has an intuitive sense of balance. Information material should display good balance, in a manner, which is interesting but not disturbing or distracting. Balance can be formal or informal. Formal balance has total symmetry and it is felt to be static and harmonious. It may, however, also be boring.

Composition can be used to direct the viewers (Wileman, 1993, p. 93). Informal balance contributes to a feeling of dynamism (Fleming & Levie, 1978; Pettersson, 1993). It may attract attention to a specific picture, to a part of a text or to the entire information material. However, imbalance and inconsis-

tent use of colours, graphics, or typography, have been found to reduce learning (Bradshaw, 1996, 2003).

Harmony in colour

Historical colour theories have included principles used to create harmonious colour combinations in architecture and painting. Perceived relationships between different pure colours have been visually represented with colours displayed on a circle, a "colour wheel." Harmonious combinations of pure colours will look good together. Colour combinations that are considered especially pleasing are called *colour harmonies* or *colour chords*. The artist may use 1) any two colours that are opposite each other in a colour wheel, 2) any three colours that are equally spaced and forming a triangle on the colour wheel, or 3) any four colours forming a square or a rectangle on the colour wheel. A colour wheel shows relationships between primary colours, secondary colours, and tertiary colours.

The "primary colours" are red, yellow and blue. The "secondary colours" are green, orange and purple, created by mixing two primary colours. Mixing of primary and secondary colours gives the six "tertiary colours." In theory it should be possible to mix all colours. However dyers, painters, and printers preferred pure pigments to primary colour mixtures, because the mixtures were too dull.

Colour and typographic elements can be used for decoration. However, it must always be very clear and easy to understand for the receiver when colour and typography is used for decoration, and when the use is meant to have some cognitive importance.

Aesthetic theories

Aesthetics is usually regarded as a branch of philosophy, along with epistemology, ethics, logic, and metaphysics. It is the youngest branch of philosophy with its own name. Aesthetics implies a hierarchical judgement in which the elements of any compositions, and their organisations, are considered more or less appealing to the senses by virtue of their ability to create higher emotional, intellectual, or moral appreciations in people.

Aesthetic theories that are based on perception favour sensation over intellect, favour seeing over reading, favour universality over cultural differences, and favour physical immediacy over social mediation (Lupton & Miller, 1999, p. 62).

The group *art and aesthetic disciplines* includes disciplines such as aesthetics, architecture, art history, computer graphics, film, fine art, iconography, iconology, illustration, music, painting, photography, and sculpture. At present the *aesthetics theory for ID* includes, but is not limited to, the following two fields of knowledge: 1) beauty theories, and 2) colour theories.

Beauty theories

Aestheticians discuss the *philosophy of art* from various perspectives, such as: definitions of art, experiences of art, interpretations of art, metaphysics of art, and production of art. Philosophers have made many unsuccessful attempts to define beauty. Three art theories concerning the nature of beauty are: 1) the formal theory, 2) the emotional theory, and 3) the relational theory.

Aestheticians value art for its originality and expressiveness. Its focus is on individual artefacts crafted through the manual and aesthetic virtuosity of the artist. Design, in contrast,

is valued for its fitness to a particular user and to a particular task (Mullet & Sano, 1995, p. 8). While a painter or a sculptor can choose any imaginable shape, a designer is limited by the function of the thing being designed. Of course many designers want to provide aesthetic experiences where possible, but the design aesthetic is always related to the intended function of the information products intended for widespread distribution and use.

This field of knowledge includes three areas of knowledge: 1) philosophy of beauty, 2) philosophy of art, and 3) aesthetics and usability.

Philosophy of beauty

The philosophy of beauty recognises aesthetic phenomena outside of the arts. These aesthetic phenomena can be found in nature, and in non-artistic cultural areas such as mathematics, morality, and science. The philosophy of beauty is concerned with fine arts only insofar as art may be perceived as beautiful. Philosophers have made many unsuccessful attempts to define beauty. However, there is much more to art than beauty. In fact in many situations art may have little, or nothing to do with beauty.

Until the eighteenth century, scholars regarded the study of beauty as the main problem of aesthetics. Since then aestheticians have devoted less effort to the *philosophy of beauty* than to the *philosophy of art*. Today it is also highly relevant to discuss *aesthetics and usability*.

Iconologia

The Italian art historian and scholar Cesare Ripa (c. 1560–c. 1645) published *Iconologia,* a didactic encyclopaedia in Rome

1593. A second edition was published in Rome in 1603, this time with 684 concepts and 151 woodcuts. The book was extremely influential in the 17th and 18th centuries and published in another eight Italian editions, and eight editions in other languages (Manning, 2002).

For more than three hundred years experts in art history all over Europe used *Iconologia* as their prime source of knowledge when they discussed description, identification, interpretation of the content of classical art. Art historians had learned, and knew the "true" language of art. However this was, and still is, not true for people in general. The general public lack these necessary frames of references.

(Further see the book *Information Design 6–Predecessors & Pioneers*.)

Judgement of beauty

One of the effects of art is the feeling that some things are beautiful and other things are ugly. In 1790 Immanuel Kant defended the validity of a "subjective universality" as a "universal voice" of the imagination through which beauty became known. He asserted that the "judgement of beauty" is "subjective," and defined aesthetic apprehension as "taste," an a priori judgement separate from cognition and morality. Aesthetic criticism implies a judgement that utilises analysis, synthesis, evaluation, and feeling in the understanding of beauty.

Before Kant, the common assumption was that beauty designated some objective feature of things. Most of the earlier theories of beauty declared that beauty was a complex relation between parts of a whole. Some philosophers called this relation "harmony". From the time of the Greeks, a common assumption was that beauty applied not only to art. Beauty manifested itself

in cultural institutions and moral character as well as in natural and artificial objects. Philosophers sometimes established very firm rules about what artists should create and what people should like. Many of these rules have been abandoned.

Psychological pleasure derived from an artwork comes from the similarity of the artist's values and sense of life to one's own values. Admiration of an artwork comes from the viewer's evaluation of the artist's skill, style, and integrity. An individual can dislike the values, the sense of life, or the theme of an artwork, but can admire the artist's skill or style.

Philosophers have made many unsuccessful attempts to define beauty. In the 18th century philosophers agreed that beauty could not be defined in terms of the qualities shared by all beautiful objects. Three theories concerning the nature of beauty are 1) the formal theory, 2) the emotional theory, and 3) the relational theory. The formal theory locates beauty in the qualities of objects. According to this theory an object may be considered beautiful when it has integrity, unity, proportion, and splendour. However, the emotional theory identifies beauty with the mental responses of the audience, the listeners and the viewers, and their aesthetic experiences. According to the relational theory beauty includes aspects from the other two theories.

Instructional value

Aesthetically pleasing visuals may *not* be of great instructional value. Dwyer and Dwyer (1989, p. 122) found that:

> The value of different types of visual illustrations is not a valid assessment of instructional effectiveness, that is, aesthetically pleasing visuals may not be of great instructional value.

It is, however, quite possible that aesthetically pleasing information material will be *noticed*, and then actually *used* in a better way than material without any obvious aesthetic qualities.

Malamed (2009, p. 203) noted that when viewers look at both pleasant and unpleasant pictures, they consistently demonstrate an emotional reaction indicated by pronounced brain activity that does not occur when they look at neutral pictures.

Information design may vary a lot in style and quality. Edward Tufte (1983, 1990, 1997) has provided information design with results from pioneering studies on how information materials used for communication can be both beautiful, and at the same time useful. His concepts of *chartjunk* and *data-to-ink ratio* are useful contributions to information design. In newspapers attractive information graphics, with "infotainment" values, attract more readers (Holmes 1993).

Philosophy of art

Alexander Gottlieb Baumgarten, a leading German philosopher, introduced the term *aesthetics* in 1735. However, a large number of philosophers from Plato to the present day have discussed "the philosophy of art." Seward Barry (1994) defined *aesthetics* broadly as an "appreciation of the beautiful," and more narrowly as a "philosophy of art, its creative sources, forms, and effects." Aestheticians try to understand the arts in broad and fundamental ways.

The philosophy of art includes traditional, philosophical theories of art: for example: Aristotelian, empiricist, existentialist, feminist, idealist, Marxist, phenomenological, Platonic, postmodernist, and rationalist aesthetics theories.

Such theoretical positions inform, but are also tested by, critical and interpretive articles about particular types or exam-

ples of artworks. The information designer may focus attention upon the visual arts – as opposed to dance, literature, music, and theatre. Philosophers have encountered difficulties in framing a theory of "aesthetic perception" and, more importantly, of the remarkable variety of visual arts. We can discuss the philosophy of art from various perspectives, such as: art and design, definitions of art, experiences of art, interpretations of art, metaphysics of art, and production of art.

Art and design

Aestheticians study all the arts, from all countries, and from all periods of history, in relation to their cultural, physical, and social environments. They try to organise knowledge of art in systematic ways. Aestheticians value art for its originality and expressiveness. Its focus is on individual artefacts crafted through the manual and aesthetic virtuosity of the artist.

Art is valued for its originality and its expressiveness. Focus is on individual artefacts crafted through the manual and aesthetic virtuosity of the individual artist. Design, in contrast, is valued for its fitness to a particular user and to a particular task (Mullet & Sano, 1995, p. 8). While a painter or a sculptor can choose any imaginable shape, a designer is limited by the function of the thing being designed. Many designers want to provide aesthetic experiences where possible, but the *design aesthetic* is always related to the intended function of the information products intended for widespread distribution and use.

Definitions of art

A number of philosophers have made unsuccessful attempts to define art. Usually definitions of art aim at establishing a set of characteristics applicable to all kinds of fine arts, as well as the differences that set them apart. After some hundreds of years of

discussions aestheticians have not yet agreed upon a definition of art. Some say that it is impossible to define art.

Art criticism may be defined as the process of judging the aesthetic qualities of visual art, mainly painting, sculpture, and architecture, but also craft. This has become a specialised field, but judgements about works of art have appeared since ancient times. In the Western world, reflection on art began with the philosophers of ancient Greece. Plato discussed proportion as the source of beauty, and imitation, as the primary mode of art. Aristotle identified different kinds of imitation. Xenocrates wrote about painting and sculpture, and the ideal synthesis of imitation and proportion.

Experiences of art

It is a common belief that a person's response to art is a mystical experience that has no basis in reality and serves no practical purpose. But the opposite may very well be true. A positive response to art is a phenomenon of reality that may reflect a person's most important values. Another belief is that art is entirely subjective and cannot be evaluated on an objective basis.

Discussions about how people experience art have been dominated by theories devised in the 18th century. Some philosophers still think of the typical experience of art as *contemplative and disinterested*, different from everyday concerns. A few modern aestheticians have stressed the continuity between aesthetic experience and everyday experience. The social sciences, such as anthropology, archaeology, and sociology, help aesthetics researchers explain the forms that art has taken in various cultures, and how the arts are related to economic activities, government, religion, and science. Recent theories of post structuralism and interpretation theory propose strategies

of critical evaluation that incorporate multiple viewpoints and accept a basic indeterminacy in meaning.

Interpretations of art

In aesthetics one area of study is concerned with the study of the interpretations of art, how people criticise, enjoy, and use art. What happens in the minds of people when they listen to music, look at paintings, or read poetry? Knowledge of psychology helps the aestheticians to understand how people act, desire, feel, hear, imagine, learn, see, and think, in relation to art and aesthetic experiences.

One question is whether strictly deductive reasoning based on premises descriptive of the artworks can back evaluative judgements. According to some opinions judgments are merely expressions of personal preferences. Thus these opinions cannot be considered true or false. Another basic question is whether conflicts over interpretations of a work of art can be settled by facts about the work, or whether more than one interpretation of a specific work is possible or not.

For the media theorist Marshall McLuhan *Cubist art* required "instant sensory awareness of the whole" (McLuhan, 1964, p. 13). With Cubism one could not ask about the content/message in the artwork, but rather consider the artwork in its entirety.

Metaphysics of art

Aestheticians ask questions like these. What access does art give people to reality? What kind of entity is a work of art? Works of art may be physical objects, such as sculptures. However, not all works of art are physical objects. A dance and a theatrical performance may be as aesthetically relevant as any physical object. A flat painting can represent spatial depth and fast move-

ments. What the painting represents may often seem more aesthetically relevant than its physical dimensions.

Some philosophers have concluded that works of art represent *mental entities*, such as visions and dreams. Other philosophers have noticed that artists may express their attitudes, emotions, and personality traits in their art, and have concluded that art works belong in a category with non-verbal communications rather than with physical objects. Still other philosophers argue that works of art exist only in the minds of their creators and of their audiences. The question whether art can provide knowledge of, or insight into, reality is as old as philosophy itself. Plato argued that art has the power to represent only the appearances of reality. The opposite position is common among modern philosophers, artists, and critics.

Since art can reflect powerfully emotional values to the beholder, art can be appreciated, enjoyed, and loved for those values. The artwork, however, is an extension of the artist and thus can never be spiritually possessed or owned by anyone else, even though the physical ownership of artefacts as well as copyrights can be transferred or sold.

Production of art

Wassily Kandinsky (1866-1944) was an influential Russian modernist, and pioneering painter and art theorist. He is considered by many to be the father of abstract art and a leader in the movement to free art from the strict bonds of tradition. According to Kandinsky art is the expression of the spiritual atmosphere of a certain period. Art evolves from the culture that inspires artistic expression. The foundation of forms, the harmony of colours, and the principle of art is an “inner necessity,” or a “right of the artist” to unlimited freedom. Art is born from

the inner necessity of the artist. Kandinsky taught at the Bauhaus school of art and architecture from 1922 until the Nazis closed it in 1933. He then moved to France. In 1912 Kandinsky argued (1912/1977 p. 1): “

> Every work of art is the child of its age and, in many cases, the mother of our emotions. It follows that each period of culture produces an art of its own which can never be repeated.

In 1925 Kandinsky published his thoughts of the role of the line, point, and other key elements of non-objective painting. A point, a small bit of paint on the canvas, is neither a geometric point nor a mathematical abstraction. It has colour and a simple or complex shape. A point can be isolated, or it can resonate with other points or lines on the canvas. A horizontal line corresponds with the ground. A vertical line corresponds with height, and offers no support. A diagonal line is un-stable.

Main questions about the production of art deal with creativity, imagination, and the role of innate ability in any artistic production. Ancient and medieval philosophers assumed the same model for producing fine art and crafts. They had no conception that the two are distinct. The present distinction between the production of fine art and crafts emerged in Western culture after the renaissance. Today most aestheticians assume that something is unique about producing fine art.

Aesthetics and usability

We could argue that the very moment that shape exceeds functionality is the point at which usability is compromised. However, we may also argue that art and aesthetic concerns in gen-

eral serve a basic human need. We may say that artistry makes a thing more usable and useful by way of making it special.

Interface design

Dreilinger (1993, p. 6) wrote about usability and aesthetics as the yin and yang of interface design. Norman (1998) asserted that if everyday design were ruled by aesthetics, life might be more pleasing to the eye but less comfortable; if ruled by usability, it might be more comfortable but uglier. The aesthetic properties of a design contribute to its ability to offer a different perspective on the world. Paying attention to the aesthetic of any design is more important than simply making things look pretty.

When the Apple Macintosh first appeared on the market people in the business world assumed that aesthetics have no useful function beyond making something look nice. Business people were accustomed to the IBM PC. They assumed that the aesthetically pleasing Macintosh interface could not possibly be as useful as the less attractive text-based interface of the PC. Aesthetic properties of a design make the product more personal, more intimate, and more special.

According to Baggerman (2000, p. 11) all design elements in interface design should serve a purpose. It is the same for information design. In information design functional properties are always more important than aesthetic properties. However, it may be an advantage if information materials also look good.

Use of material

In many areas of design the use of *material* is a very important factor. It represents many different aspects of aesthetic as well as functional qualities. As an example warning signs must be clear and easily noticed in bad and degraded conditions such as

fog, weak illumination, and smoke (Lerner & Collins, 1983). Some warning signs need adequate reflectance and good lighting equipment (Wogalter, 1999). In the area of wayfinding, or wayshowing, the right decision may be to paint lines in different colours on the floor in a hospital, or use reflecting materials in signs. When messages are printed the use of paper, or plastic, is of vital importance. The material has to be "right" for the situation.

Perceptual aesthetics

Unlike the classical tradition perceptual aesthetics seeks meaning through the process of becoming or developing according to nature through perceptual dynamics (Seward Barry, 1994). The concept of "perceptual aesthetics" provides us with a unified approach to art that reveals a cross-pollination of perceptual insights and aesthetic insights. A perceptually based approach to art provides a simple and more basic system of aesthetic judgement than do approaches based on morality, contemporary manners, and taste of style. Perceptual aesthetics is based on Gestalt psychology and its understanding of the perceptual process. Perceptual aesthetics seeks to understand how art may be structured. Here simplicity regularity, and symmetry provides the foundation from which to judge the effectiveness of composition in art.

Aesthetic experience in instructional design

In 1934 the American educational reformer John Dewey (1859–1952) argued that aesthetic is a quality of experience that "possesses internal integration and fulfilment" (Dewey, 2005a, p. 46). Dewey emphasized that aesthetic experience is an everyday

life experience, not something that takes place just on a special occasion.

According to Parrish (2005) Dewey's thoughts from the 1930s brings insights to *instructional design*. These insights enhance instructional practices (Uhrmacher, 2009). Instructional designers frequently point to their affiliations with other design disciplines and look to them as useful analogues of their practice (Parrish, 2005). Aesthetic aspects are of high importance to both designers and end-users in many design disciplines.

Parrish (2009) suggested that "an instrumental view of learning may consider only the immediately measurable outcomes of a learning experience, particularly its impacts on cognition, behavior, or performance" (p. 513). However, aesthetic, cultural, emotional, political, and social qualities of experiences have more than immediate rewards. Parrish (2009) provided principles that contribute to developing the aesthetics of instructional design:

- Designing clear phases of the learning experience: Challenge, engagement, and Conclusion/Resolution.
- Learners are made active, not passive recipients of information.
- Designing instruction according to concrete activities not to obscure constructs.
- Designing the setting of learning in a way that all the content and activities of the lesson become integrated in coherent manner.
- Being a role model of an active learner while being careful about the principles above.

For Parrish, Uhrmacher, and many others aesthetics is far more than beauty. The opposite of aesthetic experience is boredom, disengaged habitual behaviour, or imposed labour.

Colour theories

Colour has probably always been considered as important for people. The *Blombos Cave* in South Africa has rich deposits from 100,000–70,000 years ago (Henshilwood et al. 2009). Here red ochre pieces have been deliberately engraved or incised with abstract geometric designs, maybe the oldest known human "artwork."

At the beginning of the 7th century pope Gregorius the Great (about 540–604) had said that pictures are used in churches so that those who cannot read at least can look at the walls and understand what they cannot read in books (Piltz, 2007, p. 128; Sandquist Öberg, 2007, p.171). Gregorius the Great presented his insights and views in a new and simple manner (Hill, 2008, p. 169).

From about 1250 *Biblia Pauperum* consisted of a collection of about 50 colourful hand-painted loose pages (Cornell, 1925). The purpose of *Biblia Pauperum* was to recount the teachings of the Bible to the illiterate, who were at that time in the majority among the inhabitants in most countries.

The *colour theory* and the colour principles that *Leon Battista Alberti* published in *Della Pittura* (On Painting) have influenced the use of colour in the visual arts. Classical painters like Leonardo da Vinci, Michelangelo, Raphael, Peter Paul Rubens, and Rembrandt, worked with colourful compositions with great sense of colour and light. Leonardo da Vinci set out his beliefs on colour theory in his *Treatise on Painting*, which was not published until 1651. He wrote that black and white was

indeed colours, and he assigned white, yellow, green, blue, red, and black as the simple or primary colours (Anderson Feisner, 2006, p. 13).

Historical colour theories have included principles used to create harmonious colour combinations in architecture and painting. This field of knowledge includes three areas: 1) colour wheels, 2) colour systems, and 3) colour for information.

Colour wheels

Perceived relationships between different pure colours have been visually represented with colours displayed on a circle, a "colour wheel." Harmonious combinations of pure colours will look good together. Colour combinations that are considered especially pleasing are called *colour harmonies* or *colour chords*. The artist may use 1) any two colours that are opposite each other in a colour wheel, 2) any three colours that are equally spaced and forming a triangle on the colour wheel, or 3) any four colours forming a square or a rectangle on the colour wheel. A colour wheel shows relationships between primary colours, secondary colours, and tertiary colours.

Every historical colour wheel is a visual representation of a *specific colour theory* (Anderson Feisner, 2006). In 1704, Sir Isaac Newton made the first colour wheel. He split white sunlight into red, orange, yellow, green, cyan, and blue.

In 1810 Johann Wolfgang von Goethe created a colour wheel showing the psychological effect of each colour. The "primary colours" are red, yellow and blue. The "secondary colours" are green, orange and purple, created by mixing two primary colours. Mixing of primary and secondary colours gives the six "tertiary colours." In theory it should be possible to mix all colours. However dyers, painters, and printers preferred

pure pigments to primary colour mixtures, because the mixtures were too dull.

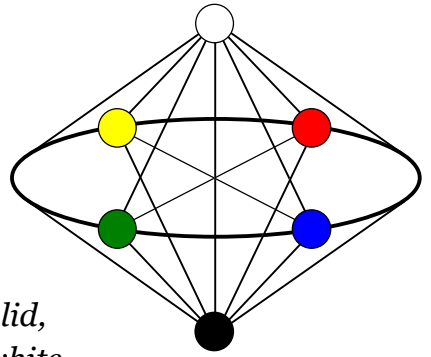
Colour systems

There are many theories about how perception of colours actually works. Colour can be described in aesthetical, physical, physiological, psychological, and technical terms. Hue, value, and saturation describe what we see when we look at pictures as well as the real world. Intensity, purity and wavelength are physical dimensions. The relationship between brightness, hue, lightness and saturation is very complicated. Colour is reflected in and through light. There is nothing yellow in a banana. It's all in how it is perceived. For practical use in art and in industry several different systems providing numerical indexes for colour have been developed.

The Natural Colour System

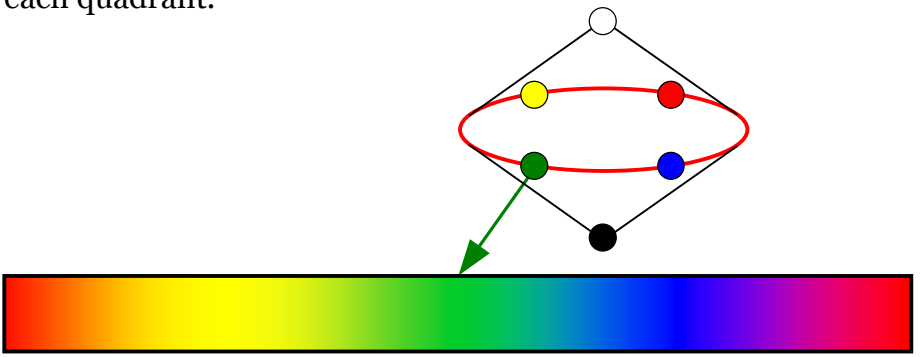
In 1925 Hering based his "natural system" on man's natural perception of colour that presupposes two pairs of chromatic colours blocking each other, red/green and blue/yellow. Hering's "natural system" is the principle for the *Natural Colour System* (NCS), developed during the 1970s in the Swedish Colour Center Foundation in Stockholm (Hård & Sivik, 1981).

From a perceptual point of view, we perceive six colours as "pure." Black and white are achromatic colours. Yellow, red, blue, and green are chromatic colours. These six colours are called elementary colours. All colours that are not pure elementary colours have a varying degree of resemblance to several elementary colours. Thus every possible colour can be described with a specific location in a three-dimensional model, a twin cone, called the "NCS Colour Solid."



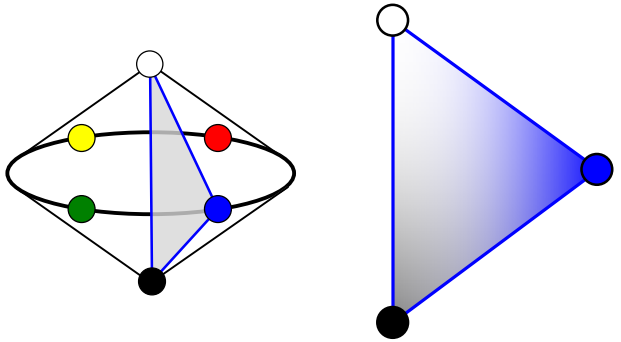
The NCS Colour Solid with the six elementary colours. Yellow, red, blue, and green are all located on the circumference of the Colour Circle. The Colour Triangle is any vertical sector through half of the NCS Colour Solid, such as, e.g., white–blue–black–white.

The chromatic elementary colours yellow, red, blue, and green are all located on the circumference of the *Colour Circle*. One hundred steps, thus describing the hue of a colour, can divide each quadrant.



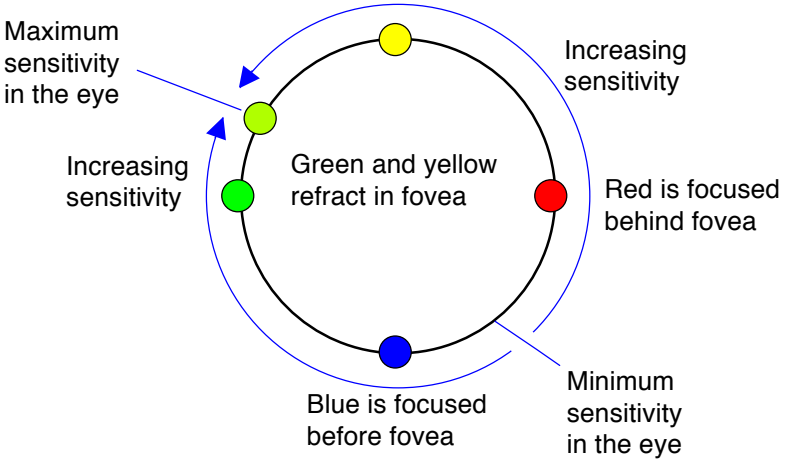
This figure illustrates a cut and opened circumference of the colour circle, here starting with red and ending with red.

The *Colour Triangle* is any vertical sector through half of the NCS Colour Solid. It is used to describe the nuance of a colour, i.e., its degree of resemblance to white, black, and the pure chromatic colour of the hue concerned (chromaticness).



There are many thousands of colour triangles. In this example the figure illustrates the colour triangle ending in blue.

When we want to describe a colour using the colour triangle and the colour circle, it is done in the following sequence: blackness, chromaticness, and hue. For example, a colour of 10 percent blackness, 80 percent chromaticness, and with a hue of Y70R will have the notation 1080-Y70R.



The NCS Colour Circle combined with information on the eye's sensitivity.

Some other colour systems

The NCS places emphasis on qualitative variation in the colour sensation whereas the Munsell System is based on equally spaced visual scales. Both systems are based on surface colours. The *Munsell Colour System* (MCS) was introduced in 1905 and it has been modified several times. The system consists of fixed arrays of samples that vary in hue, lightness (here called value), and saturation (here called chroma). The value scale ranges from white to black with nine steps of grey. Forty equal steps in a circle represent hue. The value and the hue are related to each other by a maximum of sixteen "saturation steps."

There are many theories about how perception of colours actually works. In 1807, Young proposed a tri-chromatic colour vision system. In 1924, Young's theory was formalized by von Helmholz, who proposed hypothetical excitation curves for three kinds of cones in the retina, sensitive for red, green, and blue.

In the *Hue Lightness Saturation System* (HLS), the hues are arranged as circles on the outside of a double cone resembling the NCS Colour Solid (Murch, 1983). Hue specifications start with blue at 0° and then follow the spectral order around the circle. Lightness and saturation are defined as percentages from 0 to 100. The HLS system is easy to use for colours on the surface of the model. However, colours inside the model are difficult to define. As in the Munsell- and NCS-systems, brightness creates problems.

The *Hue Value Saturation System* (HVS) is a model that is rather similar to the NCS-system but it utilizes another coding (Samit, 1983). Here value is defined as the relative lightness. White has full value and black has no value at all.

There are many other colour systems, colour wheels, and colour circles. Today printers who use modern *subtractive colour methods* use magenta, yellow, cyan, and black as primaries. Colour scientists often use the *additive primaries*, red, green and blue (RGB). These colours are used for anything light-based visual displays, like computer monitors, and television screens. People who are specially trained can use the RGB proportions as a colour description system. However, this is not possible for people in general.

In web design colours are defiend with a six-digit hexadecimal number or triplet, a *hex value/hex triplet*. Colours can be specified in the format #RRGGBB, where RR, GG, and BB are the hexadecimal values for red, green and blue values of the colour. The values varies from zero to maximum 255 for each component.

Colour for information

Colour is regularly used in printed materials, not only in illustrations, but also in the text itself. Colour can be used to clarify the structure of the text and to make learning easier. Certain parts of the text may be printed with colours or printed on top of backgrounds in different colours. Black type has good contrast to many light background colours. The legibility will always be affected when there is insufficient contrast between the type and the background.

From many experiments, it is clear that people prefer colour in visuals. To some extent colour is a language of its own. Colour enhances the attention and perception of a visual message. If people like the contents in a picture, they like them even more when the visual is presented in colour. Advertising is

known to be much more effective when visuals are in colour than in black and white.

We can use colour to clarify the structure of a text, group elements, indicate meaning, and to make learning easier. Colour can be used as an important and a successful part of information design (Bradshaw, 2001; Dwyer, 1971, 1978; Hannafin & Peck, 1988; Lipton, 2007; Moriarty, 1991; Muter & Marrutto, 1991; Pettersson, 1989; Scharff, Hill & Ahumada, 2000; Winn, 1993; Wogalter, 1999).

Inconsistent and improper use of colour can be distracting, fatiguing, and upsetting, and it can actually produce negative results and reduce learning. It should also be remembered that some people are red-green colour blind and they perceive these hues as grey.

(See the book *Information Design 3–Image Design* regarding *Use of colour*, and the book *Information Design 5–Cognition* regarding *Colour blindness*.)

Contributions for ID

The *aesthetics theory for ID* contributes to information design with valuable facts, practices, principles, and theoretical approaches. Some examples of important concepts are: aesthetic design, additive colour, aesthetic proportions, aesthetically pleasing, architecture, balance, beauty, colour chords, colour circles, colour harmonies, colour systems, colour theories, colour wheels, composition, decoration, divine proportion, fine art, golden ratio, golden rectangle, golden section, harmony principle, illustration, material, philosophy of art, philosophy of beauty, photography, primary colours, proportion, quality, secondary colours, subtractive colour, and tertiary colours.

Here are some facts, hypotheses, and postulates based on the aesthetics theory for ID.

- Aesthetic designs are perceived as easier to use than less-aesthetic designs.
- Aesthetic value is the aggregate effect of all picture variables.
- Colour can be described in aesthetical, physical, physiological, psychological, and technical terms.
- Colour enhances the attention and perception of a visual message.
- Colour wheels are visual representations of colour theories.
- Every historical colour wheel is a visual representation of a specific colour theory.
- For the receiver it must always be absolutely clear if colour is used for decoration, or if it has some cognitive importance.
- Graphic form, text, and visuals should always work together to fulfil information design objectives.
- Imbalance and inconsistent use of colours, graphics, or typography, have been found to reduce learning.
- Informal balance contributes to a feeling of dynamism.
- People in different cultures may have varying opinions of harmony.
- Proportions according to the “golden section” are not always appropriate in information design.

Functional principles

The group "*Functional principles"* includes six message design principles: *Defining the problem, Providing structure, Providing clarity, Providing simplicity, Providing emphasis,* and *Providing unity*. Guidelines that are based on these six principles will assist the information designer to design information materials that are well suited for the intended receivers.

(See the book *Information Design 1–Message Design* for information regarding *Defining the problem*, *Information Design 2–Text Design* for information regarding *Providing structure,* and *Information Design 3–Image Design* for more information regarding *Legibility of pictures*.)

Providing clarity

The *legibility of a graphical message* is determined by the technical design of texts and pictures, that is, their *clarity*. The information designer will have to make the content stand out clearly from the background. In general information materials should be as clear, simple, unambiguous and transparent as possible. We should avoid unusual typefaces, as well as fonts that are too small or too large. We read words in a text as "pictures," not letter by letter. Typeface and font size must be adapted to meet the limitations of the medium and technical production. A message has good legibility if it is easy to read, and if the reader can easily see and distinguish all different parts of the message.

Good legibility is always economically advantageous, whereas poor legibility is a costly business. Good models make the production of documents simple and inexpensive. In my view it is not economical to cram too much information on a

page. It is better to edit the text and reduce its bulk, and thereby increase its legibility.

Legibility can be measured rather objectively and its quality is assessable whether we understand the content of the message or not. Dissatisfaction with the execution of a message may also cause dissatisfaction with the content of the message (Pettersson, 1989). Therefore the information designer has to consider the legibility of text printed on paper, displayed and projected on screens, as well as legibility of pictures, legibility of layout, legibility of symbols, legibility of numerals, and legibility of colours.

Legibility of text

Depending on the purpose, we can read a text in several ways. An active reader makes good use of the structure embedded in the text. The preface, the table of contents, the headings, as well as the captions and the illustrations provide an overview of the content in the whole book.

The concept "legibility of text" refers to a text's external properties (Lipton, 2007; Pettersson, 1993; Williams & Tollet, 1998). These are properties such as letter size, inter-line distance, line length, the distance between letters, the number of letters per line, the distance between words, headings, the subdivision into paragraphs, headings in the margin, the layout, colour of the printing ink and paper, the paper quality, etc. These different external properties have not been found to have a drastic effect on legibility as long as the text is presented within the framework of variation normally found in contemporary books.

Furthermore legibility refers to production and material quality, environmental conditions, room lighting and tempera-

ture, noise level, et cetera. Principles for legibility are presented in the following sub-sections: *Legibility of print media, Legibility of text on wall charts, Legibility of text on computer screens,* and *Legibility of projected texts.*

Legibility of print media

A printed text in books, handouts, reports and other printed documents must have good legibility. Therefore the information designer will have to:

- Use clear, direct, simple and transparent typography.
- Use a common typeface, between nine and twelve Pica points, for continuous text in a book, a pamphlet, or a report.
- Restrict the number typefaces and only use a few per information material.

See the two chapters *Typography* and *Layout* for more information.

Legibility of projected texts

In verbal presentations, many of the overhead transparencies, slides, filmstrips, and projected computer presentations consist mainly, or sometimes only of text. Here lettering must be considered carefully in order to guarantee good legibility for all listeners. In preparing the material the information designer should:

- Use no more than six rows of six words in each image, set in a linear typeface, with characters large and bold enough.
- Maintain a good contrast between foreground and background.
- Avoid graduated and tonal background fills.

Before the presentation the presenter will need to reduce room illumination and clean slides, lenses, and screens. During the presentation it is important to really project the images in focus and on the screen, preferably horizontally. (See the chapter *The elements of graphic design* for more information.)

Legibility of text on wall charts

A wall chart must have good legibility. The information designer should:

- Set text bold and large enough, adjusted to the reading distance.
- Use lower case letters and avoid all-capital printing for running text.
- Restrict the number typefaces.

Posters and wall charts shall be read from some distance. Therefore text should be large enough (Ormrod, 1989; Pettersson, 1993; Wileman, 1993), and bold enough (Mayer, 1993; Pettersson, 1993; Wileman, 1993, p. 79). Too small or too large lettering will impair reading. The text on a poster or a wall chart may often have to be ten times larger in size than a text in a book or on a print out. Text should be set in lower case letters, because all-capital printing has been shown to markedly reduce the speed of reading (Henney, 1981; Poulton and Brown, 1968). Since the texts on posters and wall charts should be short it may be a good idea to use a sans serif typeface like Arial or Helvetica. If so the running text will need some extra space between the lines (Collier & Cotton, 1989).

Legibility of text on screens

Compared with traditional graphic presentations, a presentation of information on visual displays such as television sets and

computer terminals is very limited. Still, information may be presented in many different ways. The design may vary with respect to spatial organization like directive cues, colours, columns, headings, justification, lines, scrolling text, spacing, and twinkling characters or words. A text on a computer screen must have good legibility. The information designer should:

- Use typefaces designed for screen display.
- Use black text on a white or yellow background.
- Avoid the use of all capital letters.

(See the two chapters *The elements of graphic design,* and *Layout* for more information.)

Legibility of pictures

A message has good legibility if it is easy to read, and if the reader can easily see and distinguish all different parts of the message. Legibility can be measured rather objectively and its quality is assessable whether we understand the content of the message or not. Dissatisfaction with the execution of a message may also cause dissatisfaction with the content of the message. Therefore the information designer has to consider the legibility of text printed on paper, displayed and projected on screens, as well as legibility of pictures, legibility of layout, legibility of symbols, legibility of numerals, and legibility of colours. The information designer should:

- Use picture elements that are bold and large enough.
- Use a style guide for picture elements in schematic pictures.
- Set words in images and pictures bold and large enough to read.

(See the book *Information Design 3–Image Design* for more information in these areas.)

Legibility of layout

An “informative layout” must have good legibility. Therefore the information designer should:

- Use standard page sizes with standard grids for pre-planning of pages.
- Use a clear and simple layout.
- Use arrows, bullets, lines, and symbols in various colours; also margin notes, repetition, and space to highlight relevant information.

(See the chapter *Layout* for general information.)

Legibility of symbols

The use of symbols has a long tradition and various symbols can be used to aid communication. The information designer should:

- Use distinct colours and simple graphical elements to design symbols that will function in any size.
- Design solid figures with a distinct contrast to the background.
- Use characters and graphical elements that are bold, distinct and large enough.

(See the book *Information Design 3–Image Design* for more information.)

Legibility of numerical values

Numerical data and information can be presented in tables and in graphs. A table in an information material must have good legibility. Therefore the information designer should:

Tables

- Use type between 8 and 12-point size for table cells.
- Use vertically oriented tables.
- Use rounded off numbers.

Graphs

- Compare lengths of variables to show their relationships.
- Compare areas of variables to show their parts of a whole.
- Use actual figures in graphs when accuracy is needed.

(See the chapters *The elements of graphic design* and *Layout* for more information.)

Legibility of maps

Maps must have good legibility. Therefore the information designer should:

- Use bold and distinct symbols in a consistent size.
- Restrict the number of typefaces and complexity of patterns.
- Provide distinct contrast in form and dimensions.

(See the book *Information Design 3–Image Design* for more information.)

Legibility of colour

Colour can be used to clarify the structure of a text. Certain parts of the text may be printed with colours or printed on top of backgrounds in different colours. Colours used in informa-

tion materials must have good legibility. Therefore the information designer should:

- Use a light or a dark background colour appropriate to the content, and then use a colour with good contrast for the figure or text.
- Make sure that differences between colours are clear and obvious.
- Combine colours with shape in warning signs.

Colour is regularly used in printed materials, not only in illustrations, but also in the text itself. The most legible combinations of print colours are black or dark brown text on a light yellow background (Pettersson, 1989; Pettersson et al., 1984a). Black type on a white background gives the highest and most comfortable contrast for sustained reading (Bradshaw, 2001; Lipton, 2007; Muter & Marrutto, 1991; Scharff, Hill, & Ahumada 2000). Other combinations may attract more attention but are less legible and, thus, require larger type. The legibility will always be affected when there is insufficient contrast between the type and the background. There are strong cultural differences in interpreting the meanings of colour.

Here black type on a yellow background gives good legibility. The orange text on the same background gives poor legibility.

The background colour of a computer screen should be "fairly light" or "fairly dark," depending on the content. The text

displayed on a screen should have an opposite ("fairly dark" or "fairly light") colour (Bradshaw, 2001). The most legible colour combination is black text on a white or yellow background (Pettersson et al., 1984a).

Unfortunately, red and green are often used as discriminating colours in symbols and in warning signs. Since many colour-blind people perceive red and green as grey, colour can only be used to code the information redundantly. Colour may be combined with shape, and position, or with both, which is often seen in traffic signs.

Providing emphasis

The most important elements in information material may be emphasized to enhance attention and perception. A dark dot in a light field and a jog in a straight line are two good examples of emphasis. Emphasis may be used to *attract*, *direct* and to *keep* attention. Typography and layout will better show the structure and the hierarchy of the content in the information material when important parts are emphasised. The information designer should:

- Use specific elements for emphasis.
- Use clear contrasts for emphasis.
- Use variables like complexity, directionality, exaggerated features, humour, isolation or motion for emphasis.

It is possible to provide emphasis in information material with the help of a number of specific design elements. Generally speaking highlighting cues and emphasis in a message will result in attention to that message. We should, however, never overuse any accenting techniques because if we do they may completely lose their meanings and their power to emphasize

(Dwyer, 1978; Hartley, Bartlett, and Branthwaite 1980; Benson, 1985; Bausell and Jenkins 1987).

See the section *Emphasis* in book 3 *Image Design* for emphasis in pictures and symbols.

Emphasis in text

There are a several possibilities to emphasize elements in typography. We can use boldface, colour, italics, key words in red, light against dark, small against large, and underlining key words. In order not to confuse the readers, it is important to establish a consistent system for how to signal emphasis.

When used purposefully, contrast can reveal the structure of the content helping readers see relationships among the parts (Ivory, Sinha and Hearst, 2001). Typographic cuing generally refers to the use of bold or italic type or underlining to signal the important ideas in a text. There is little doubt that cuing does work well in drawing attention to the cued material (Glynn, Britton and Tillman, 1985). The consensus is that readers are more likely to remember cued ideas than un-cued ideas (Hartley, 1987). In an experiment with 300 subjects Cisotto and Boscolo (1995) found that the use of paragraph headings improved learning. However, underlining of relevant information did not have the same effect. Underlining did not improve learning.

Headings should always be relevant and identify the subject matter. The purposes of headings are to attract the attention of the readers, make the subject matter readily apparent, and indicate the relative importance of different items in the document. To avoid too large masses of text, it is a good idea to divide the text into sections, subsections, and paragraphs. Headings on different hierarchic levels will provide the readers with refer-

ence point and help them to organize information cognitively for better retention and recall. Headings set in different type versions aid comprehension of the text content (Jonassen, 1982).

Normally boldface and italics will not be used for continuous text. Italic print is read more slowly than regular type and is also disliked by many readers (Tinker, 1965). However, the information designer can decide to use boldface and italics for emphasis of parts of a text (Lipton, 2007; Mayer, 1993; Tinker, 1965).

The use of underlining and all capital letters should be restricted to headings and titles, if they are used at all. Usually bold and italics are quite sufficient. Underlining in the middle of a sentence makes the lower line more difficult to read (Isaacs, 1987). Shadow and outline letters should be avoided.

There are a few other possibilities to emphasize paragraphs in texts, such as adjunct question to relevant information (Mayer, 1993) and statements of objectives for emphasis (Briggs & Wager, 1989; Mayer, 1993).

Emphasis in layout

Most people read instructional materials selectively. Readers rarely, if ever, begin at the beginning and read straight through to the end of a document. Usually we use a combination of browsing, reading headings, looking at illustrations, reading captions, reading certain parts carefully, skimming others, and avoiding some parts completely. Many readers will only spend time on a limited amount of information in a newspaper. It is known that elements like headings, photos, drawings, and information graphics attract attention and often are entry point into a page. Size and placement of such elements influence how

the reader will actually read the page. Many readers may jump over too large pictures and never look at them at all.

The competition for our attention is usually very fierce in commercial arts and in advertising. Thus discontinuity is often used intentionally to attract and even to hold attention of the viewers. The intended message may be hidden within verbal or visual puns, within metaphors, satires, parodies, or within humour. In these cases, designers break the traditional rules or guidelines of instructional message design. It might also be possible to deliberately use the unexpected to attract attention to instructional materials.

There are a several possibilities to emphasize elements in typography and layout. The information designer can use a number of "tools," such as:

- Areas of colour (Mijksenaar, 1997).
- Areas of shading (Mijksenaar, 1997; Pettersson, 1989).
- Arrows (Beck 1984; Hartley, 1987; Jonassen & Kirschner, 1982; Lamberski & Dwyer, 1983; Mayer, 1993; Pettersson, 1989; Winn, 1989;).
- Black type on a white background (Muter & Marrutto, 1991; Scharff, Hill & Ahumada, 2000).
- Bold against standard (Pettersson, 1989).
- Boldface (Hartley, 1987; Jonassen & Kirschner, 1982; Mayer, 1993).
- Boxes (Mijksenaar, 1997).
- Bullets (Mayer, 1993).
- Circles or ovals around objects (Pettersson, 1989).
- Clear contrasts (Pettersson, 1989).
- Colour (Winn, 1993; Wogalter, 1999).
- Colour against no colour (Pettersson, 1989).

- Colour coding (Bradshaw, 2003; Hannafin & Peck, 1988)
- Complexity (Pettersson, 1989).
- Contrast (Muter & Marrutto, 1991; Pettersson, 1989; Scharff, Hill & Ahumada 2000).
- Detail against no detail (Pettersson, 1989).
- Directionality (Pettersson, 1989).
- Headings (Hartley, 1987; Jonassen & Kirschner, 1982; Mayer, 1993).
- Highlight relevant information (Mayer, 1993).
- Icons (Mayer, 1993).
- Illustrations (Mijksenaar, 1997).
- Imbalance (Fleming & Levie, 1978).
- Irregular design (Fleming & Levie, 1978, 1993)
- Italics (Mayer, 1993; Mijksenaar, 1997; Pettersson, 1989).
- Key words in red (Fleming & Levie, 1978).
- Larger font (Mayer, 1993).
- Light against dark (Pettersson, 1989).
- Lines (Mijksenaar, 1997).
- Logos (Mijksenaar, 1997).
- Margin notes (Mayer, 1993).
- Repetition (Mayer, 1993).
- Shaded areas against plain backgrounds (Pettersson, 1989).
- Small against large (Pettersson, 1989).
- Symbols (Mijksenaar, 1997).
- Tonal areas against plain backgrounds (Pettersson, 1989).
- Underlining key words (Fleming & Levie, 1978; Mayer, 1993).
- Unexpected design (Fleming & Levie, 1978, 1993)
- Unstable design (Fleming & Levie, 1978, 1993).
- Variation out of context (Pettersson, 1989).

- White space (Hartley, 1987; Jonassen & Kirschner, 1982; Mayer, 1993).

Italics give emphasis to a word or a group of words. In order not to confuse the readers, it is important to establish a consistent system for how to signal emphasis. Use italics for emphasis sparingly; too many italicised words may reduce the emphasis effect.

Providing unity

Aesthetic theories that are based on *perception* favour sensation over intellect, favour seeing over reading, favour universality over cultural differences, and favour physical immediacy over social mediation (Lupton & Miller, 1999, p. 62). Aesthetics treats the conditions of sensuous perception and aims to establish general principles of art and beauty, and of proportion and harmony.

Unity suggests an "overall togetherness" in the information material. It is more or less the opposite to emphasis. According to some authors unity is the fabric about which the entire information structure with its text elements and pictures is interwoven. In a design that lacks unity the different elements compete for attention. It is chaos and it creates confusion for the receivers. However, the systems for desktop publishing make it possible for the individual author to integrate words and visuals to aid communication.

All kinds of inconsistencies in an information material may confuse the receivers. It may become unnecessarily complicated for them to interpret and understand the intended content of the message. There is a close relationship between guidelines aimed at providing unity and guidelines aimed at providing

harmony. To provide unity in information material the information designer can:

- Use style and terminology in a consistent way in each specific information material.
- Use layout and typography in a consistent way.
- Use highlighting techniques in a consistent way.

To get maximum impact from a picture it should be introduced in the text between the appropriate paragraphs. Each picture should also have its own caption. Substantial research has clearly shown that learning efficiency is much enhanced when words and visuals interact and supply redundant information (Levie & Lentz, 1982; Levin & Lesgold, 1978). The improvement sometimes exceeds sixty percent and averages thirty percent.

Many authors have found that pictures should be put as close to the relevant running text as possible (Benson, 1985; Braden, 1983; Clark & Lyons, 2004; Haber & Hershenson, 1980; Hartley & Burnhill, 1977a; Lidman & Lund, 1972; MacDonald-Ross, 1977; Mayer, 1993; Mayer & Sims, 1994; Mayer et al., 1995; Moreno & Mayer, 2000; Pettersson, 1989, 1993; Schriver, 1997; Wright, 1982). Illustrations in textbooks are often "forgotten" by students as well as teachers; therefore it is important for editors and information designers to clearly instruct the learners to make good use of the pictures (Hannus, 1996; Peeck, 1993, 1994; Reinking, 1986).

Visuals designed to complement oral and printed instruction should both have a high correlation with the message they are attempting to support, and need to be designed to provide the learning environment with specific types of stimuli needed by particular types of learners, to achieve special educational objectives.

Wileman (1993, p. 93) provided the following checklist with questions for evaluation of visuals with reference to unity:

1. Are the visual elements (words, pictures, graphic design elements) well laid out?
2. Does the margin unify or add to the composition of the visual?
3. Does the entire message (words and images) fill the screen?
4. If words are used, is it clear which words go with what pictures?
5. Does the composition direct the viewers to the centre of attention?
6. Does the composition support what is being taught?

We may distinguish between three types of unity. *Pragmatic unity* is that the characteristics of the viewer can work for or against recognition of an image. *Semantic unity* is the possibility to identify an image. *Syntactic unity* is an acknowledgement that an image exists. A minimum requirement is that the bounds of each image should be discernible.

Typography

Typography is the art and technique of arranging type in order to make the message visible and it provides a large number of possibilities to make the structure in a document clear (Benson, 1985; Tinker, 1963, 1965). The graphic designer will select typefaces, point sizes, line length, and line spacing and alter the presentation of headings, running text, captions, lists, tables, and ornaments.

Typography determines the clarity of the message and has been noted to have the capacity to influence brand perception (Childers & Jass, 2002, p. 104) and consumer motivation (McCarthy & Mothersbaugh, 2002, p. 664). Graphic designers use typography in different ways. Over time, we have become accustomed to associating certain styles of typographic design with certain kinds of content and tone of voice (Moys, 2011).

Any typographic feature that reduces ability to readily recognize and discriminate individual letters within words and words within larger text units will decrease legibility (McCarthy & Mothersbaugh, 2002, p. 670). “Novelty” or “incongruity” may have the inverse effect of generating interest in advertising (McCarthy & Mothersbaugh, 2002), and this is certainly also true in information design.

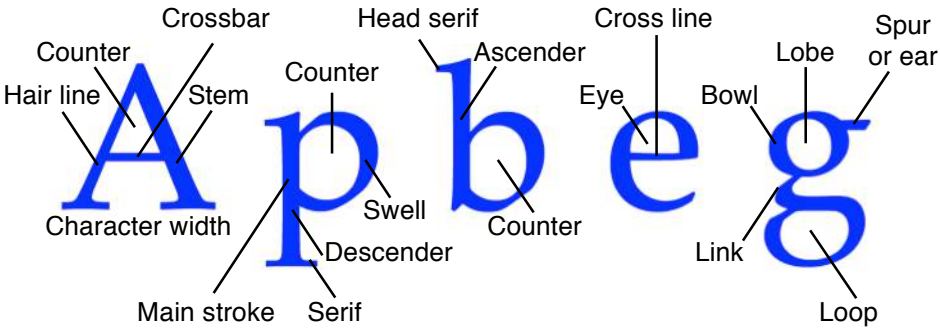
Type

The words we need in books and other graphical media use *type*. The term *type* refers to all characters that are used in printing. It may be hard to imagine how people lived 500 years ago without type. At that time all texts were copied by hand or they were printed from wood blocks. Today printers use thousands of type styles. A type style makes somewhat the same im-

pression on the reader that a speaker's voice makes on the listener. Some type may suggest strength. Others may suggest delicacy.

Design of characters

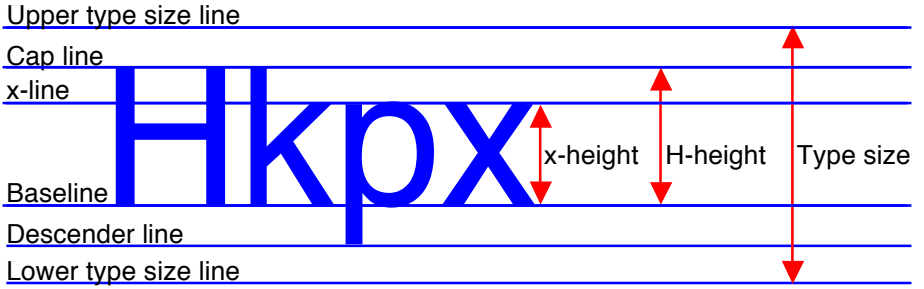
Individual characters can be designed in many different ways (Strizver, 2006). Many characters are based on geometrical shapes like the circle, oval, rectangle, square, and triangle. Circles and triangles need to have a slightly larger height (3–4%) than a corresponding square.



The terminology in typography is based on hot metal type composition. Here are some examples.

The differences between many typefaces are subtle. It is not always possible to see the differences without special training. Typefaces can be identified by looking for classic traits, such as the shape of specific parts of lower-case letters. A complete assortment of characters of the same style and size is called a *font* or a *font of type*. Thus, each typeface appears in many different fonts. However, in computer manuals the word font is sometimes used to mean typeface, which is of course confusing.

Imaginary lines are used in the positioning of letters. The baseline is the main point of reference in typography. The x-height is the vertical space occupied by lowercase letters (excluding ascenders and descenders). The H-height or cap height is the height of capital H. The point size or type size is the vertical space allowed for any character of a typeface.



Imaginary lines are used in the positioning of letters. Helvetica 72 point is used in this illustration.

When designing characters for digital environments, it is important to consider how to compensate for the limitations in fonts that are designed for traditional printing. All fine lines in characters present huge challenges for adaptation to screens, since they only represent a small percent of a pixel (Josephson, 2008; Bias et al., 2010). Digital-text developers improve text for low-resolution computer displays by font design, font hinting, and rendering technologies (Bias et al., 2010, p. 746). *Font hinting* refers to editing typeface outlines to available pixels. *Rendering technologies* aim to give screen text the clarity of printed text.

The lowercase letters of a and g are designed both in “one storey, or single storey, letter forms” and in “two storey letter

forms." Walker and Reynolds (2003) discussed whether 6-year-old children find serif text with "infant character forms" (e.g. variants of 'a' and 'g') easier or more difficult to read than "adult character forms." The results showed that children in the test group could read specially-designed texts set in Gill and Century, with and without infant characters, equally well.

One storey "infant character forms" (left) and "two storey adult character forms" (right).

Typefaces

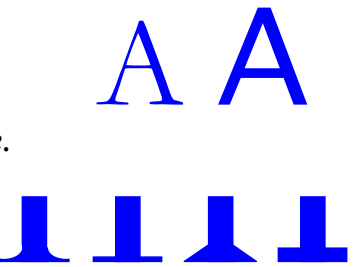
The term *typeface* refers to the general outline, the face, personality, and shape of the individual characters. During the little more than 500 years of western printing history, probably more than 60,000 typefaces have been designed (Mijksenaar, 1997). It is easy to combine them in many ways. Most of these typefaces are, however, limited in their usefulness. Differences are often subtle. It is not always possible to see the differences without special training. The distinctive details and the explicit forms of words may facilitate word recognition.

Lupton (2010, p 13) argued that: "Typefaces are an essential resource employed by graphic designers, just as glass, stone, steel, and countless other materials are employed by architects."

Experts employ several systems for classification. Classification systems may be based on chronology, on evolution, and on various elements of letter shapes. Most systems are incomplete and more or less confusing. The system that has enjoyed the largest general favour divides typefaces into four main

classes: 1) Roman type style. 2) Sans serif type style. 3) Script type style. 4) Black letter type style. Within these classes groups of type designs with important similarities form “type families.”

Roman type style with serifs (left) and sans serif type style (right). In this example we can compare Garamond and Geneva of the same size. There are four main types of serifs: bracketed serif, hairline serif, wedge serif, and slab serif.



Roman type style

The *Roman type style* includes most of the typefaces used in modern printing. These typefaces have *serifs*, finishing strokes normally at the top and at the bottom of the main strokes of letters. Serifs are not just put there for decoration. They help us distinguish between characters. Serif typefaces are often considered to make it easier to follow text lines and thus be easier to read than sans serif typefaces (Tinker, 1963), except for small letter sizes (Benson, 1985; Braden, 1985; Mackiewicz 2004). Visual psychophysical studies in adult readers have shown that serifs have little effect on legibility (Arditi & Cho, 2005).

Most typefaces in books for children are sans serif. Walker and Reynolds (2003) studied whether reading books for young children should be set in serif or sanserif type. Their results suggested that there is little significant difference in children's reading performance when Century is compared with Gill.

Serifs on characters make it easier to follow the horizontal lines with text. However this part of a word is very hard to read.

The upper parts of letters shape the images of words. Thus this part of the word is rather easy to read.

Serifs are terminal strokes, normally at the top and the bottom of the main strokes of letters in a Roman type style. This typeface is called Garamond.

Typefaces are often named after the designers who created them or after the printers who first used them. Common examples of serif typefaces are Baskerville, Berling, Bodoni, Bookman, Caslon, Century Old Style, Garamond, New Century Schoolbook, Palatino, and Times New Roman.

The French printer Nicolas Jenson worked in Italy. He perfected the first Roman style type already in 1470. In France Claude Garamond created the Garamond-style about 1540. In England William Caslon designed the Caslon-style in 1734; and John Baskerville created the Baskerville-style about 1757. In Italy Giambatista Bodoni designed a new kind of Roman type

style in 1768. For more than 200 hundred years the Bodoni-style has been called modern or modern type. Classical newspaper typefaces are Century Old Style, Ionic, Excelsior, Times New Roman, and Corona. They were all created for the hot-metal print and the rotary letterpress printing.

Sans serif type style

The *Sans serif type style* has no serifs on the characters. These typefaces provide uniform weight when there are less-than-optimal reading conditions and they are often used for headings, labels in pictures, diagrams, captions and tables (Benson, 1985; Lipton, 2007; Mackiewicz, 2004; Pettersson, 1993). Williams and Tollet (1998) suggests we should use sans serif type to improve legibility. Sans serif type can be used successfully for the body text in books, pamphlets and reports.

Common examples of sans serif type are Avant Garde, Futura, Geneva, Gill, Helvetica, Optima, Univers, and Venus. Helvetica typefaces may be the most widely used among the sans serif typefaces in the world today (Collier & Cotton, 1989). Subjects perceive san serif fonts as clean, modern and technical (Brumberger, 2003).

Serif fonts as well as sans serif fonts have been designed specifically for use on computer screens. However, sans serif fonts are still regarded more legible for screen reading than serif fonts (Josephson, 2008).

Some other typefaces

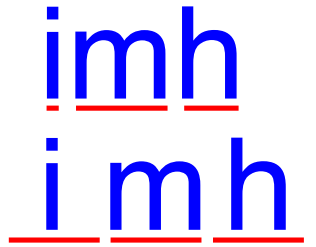
Script type style looks somewhat like modern handwriting that is carefully executed with a brush dipped in India ink. The individual characters are joined together. It is not possible to use script type for whole words in upper case, or capital letters. Examples are Constance, Palace Script, and Zaph Chancery.

Black letter type style resembles old German manuscript handwriting. Black letter type is difficult to read and rarely used in the USA. Examples are Fraktur, Rotunda, Schwabacher, and Textura.

A more modern classification scheme is the *serif-evolution system*. This system provides eight main classes: Venetian, Old Style (Dutch-English and French), Transitional, Modern, Contemporary (sans serif and square serifs), Black letter, Scripts, and Decorative letters.

Most typefaces are proportionally spaced. Then different letters are assigned different spacing in accordance with their individual sizes and shapes. However, on most typewriters and some printers the typefaces are mono-spaced. In such typefaces all the letters have the same amount of space. The letter "i" takes the same space as the letter "m". Proportionally spaced type is usually easier to read than mono-spaced type.

Note the differences in character space, especially for the letters i and m. These characters are set in 40 point Helvetica.



Size of type

Too small or too large lettering impairs reading. We read words in a text as patterns or even as a series of "word pictures," not letter by letter (Hallberg, 1992; Ingvar and Hallberg, 1989). Wilkins et al. (2009) found that the size and design of the typeface in textual material for children aged 7–9 (in the UK) may impair their speed of reading and their comprehension, and

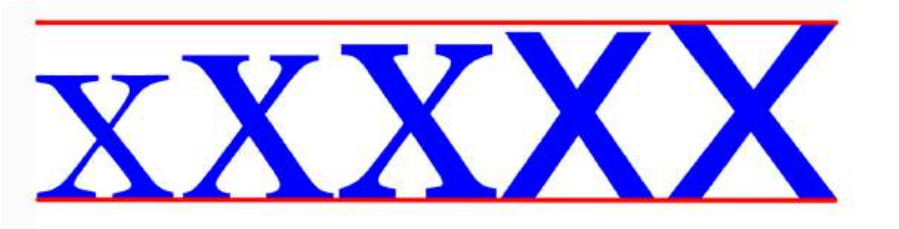
measurement of reading attainment. One study compared the speed with which sample sentences were comprehended. The sentences were printed in Arial font with an x-height of 4.2 mm (22pt) and 5.0 mm (26 pt) respectively. The sentences were verified 9% more quickly when presented in the larger typeface. Two studies compared the font Sassoon Primary with the font Verdana and showed that Verdana was read and searched more quickly.

Our perception of size is always relative. According to White (1987), some 10-point type looks gigantic and some minuscule. It all depends on the design of the face and its x-height. Letters can be varied in size and even by type to differentiate different types of data (Hartley, 1987). To achieve optimum legibility it is known that letter size must be adjusted to the visual format and the reading distance.

Height of character

The *x-height* is the vertical distance equal to the height of the lowercase letters such as x (without ascenders and descenders). Higher x-heights allow for smaller typeface size, which is just as legible but still is space saving and economical. This is important in the production of newspapers.

According to Tinker (1963) text smaller than nine points is too small to be considered legible. Text that should be read in a continuous manner should be set between nine and twelve Pica points (Benson, 1985; Bernard & Mills, 2000; Braden, 1983, 1985; Haber and Haber 1981; Tinker, 1963). A twelve point normal type is often suitable. Even after reduction in the printing process to ten point type, the text will exhibit very good legibility.



Height and width vary in different typefaces of the same size. This figure includes Garamond (left), Times New Roman, Georgia, Arial and Verdana (right). The differences in the shape and size of the characters will influence legibility.

In early readers for children the x-height is typically about 4 mm. Over the course of five years the x-height decreases to an "adult size" (about 2 mm). Hughes and Wilkins (2000) have argued that the typeface becomes too small too early in life.

In its *Publication Manual* the American Psychological Association (1996, p. 151) recommends a minimum type size of eight points in figures. The maximum size is 14 points. According to Lenze (1991) font size above twelve points slows the reading process because the reader must examine each letter individually to recognize it. Thus, we can conclude that type should be "large enough". A larger type size in a single column is preferable to a smaller type size in a double column layout. But the text on a display poster should be at least three to five times as large. A poster might require text that is at least ten times as large since it is designed to be read from a distance.

Measurement systems

Traditionally the vertical height of letters is designated in typographical *points*. However the size of such a point is somewhat different in various parts of the world. There are three basic

measurement systems used for traditional typesetting, and one main system for desktop publishing.

- The *Pica system* is used in USA and Great Britain.
  Here 1 pica = 12 points = 12 pts = .1660 inch = 4.22 mm.
  1 pt = .3516 mm (72,27 pts/inch)
- The *Didot system* is used in most parts of Europe (except Great Britain and France).
  Here 1 Cicero = 12 points = 12 p = .1780 inch = 4.511 mm.
  1 p = .3759 mm (67.6 pts/inch)
- The *Mediaan system* is used in France.
  Here 12 points = .1649 inch = 4.205 mm.
  1 pt = .3504 mm (72.5 pts/inch)
- *Desktop publishing systems* use a version of the Pica system.
  Here 1 pica = 12 points = 12 pts = 1/6 inch = .1667 inch= 4.23 mm.
  1 pt = .3528 mm (72 pts/inch)

In some situations these differences may be significant.

This is the width of 100 *Pica* points
This is the width of 100 *Didot* points
This is the width of 100 *Mediaan* points
This is the width of 100 *DTP Pica* points

This is the width of 25 millimetres
This is the width of 1 inch (25.4 mm)

Initial letters

Sometimes initial letters are larger than the running text. Initial letters may be lowered as “drop caps” or raised as “raised initial letters”. Because of the possibility to create fancy initial letters

in desktop systems, this medieval practice has become common again (Stokstadand Cothren, 2011). Misanchuk (1992) argues that fancy initial letters are not at all likely to help readers.

Different impressions

Traditional hot metal type is cast in sizes ranging from 4 points to 144 points. Photo-typesetting machines and systems for desktop publishing can produce even larger characters. Sizes of type that are in common use are 6, 7, 8, 9, 10, 11, 12, 13, 14, 18, 24, 30, 36, 42, 48, 60, and 72 points. Characters should obviously neither be too small, nor too large. In the first case we cannot read them at all. Legibility is very poor. In the latter case we can only have a few words on each line.

Too small or too large lettering impairs reading. As an example, a text on a poster should be at least five times larger than a corresponding text in a book. Newspaper print is usually eight or nine points. In books ten to twelve points are common. The following pages include five examples of a paragraph of text in five size versions: Georgia 8, 10, 12, 14, and 16 point type.

Georgia 8. Infodidactics is the methods used for teaching the various aspects of information design. The huge spread among the different disciplines makes information design an interesting, but also a complex area of research and teaching. Understanding is the goal of all scientific enterprise. When we understand a subject matter we are able to explain phenomena and predict new phenomena.

Georgia 10. Infodidactics is the methods used for teaching the various aspects of information design. The huge spread among the different disciplines makes information design an interesting, but also a complex area of research and teaching. Understanding is the goal of all scientific enterprise. When we understand a subject matter we are able to explain phenomena and predict new phenomena.

Georgia 12. Infodidactics is the methods used for teaching the various aspects of information design. The huge spread among

the different disciplines makes information design an interesting, but also a complex area of research and teaching. Understanding is the goal of all scientific enterprise. When we understand a subject matter we are able to explain phenomena and predict new phenomena.

Georgia 14. Infodidactics is the methods used for teaching the various aspects of information design. The huge spread among the different disciplines makes information design an interesting, but also a complex area of research and teaching. Understanding is the goal of all scientific enterprise. When we understand a subject matter we are able to explain phenomena and predict new phenomena.

Georgia 16. Infodidactics is the methods used for teaching the various aspects of information design. The huge spread among the different disciplines makes information design an interesting, but also a complex area of research and teaching. Understanding is the goal of all scientific enterprise. When we understand a subject matter we are able to explain phenomena and predict new phenomena.

As we can see from these examples different size versions of a text provide different impressions. In information design it is important to find a good balance between our need for a general overview and a good legibility of individual words. We need a balance between “not to large” and “not to small.” In books, magazines, and newspapers larger type may be used for head-

ings. Below are some examples of the word “information” in five larger size versions: Helvetica 18, 24, 28, 36 and 48 point type.

information 18

information 24

information 28

information 36

information 48

Which type sizes do you prefer for different headings in a book and in a technical report?

Information	Information
Information	Information

Fine lines in Times (upper line) may sometimes almost “disappear.” It is better to use a sans serif type, like Helvetica, when the text is white on a black background (bottom line). Both examples are set in 14 points.

Often text is printed with black ink. However text may also be printed in a number of colours. This is especially easy in documents for the Internet. The use of colour will influence im-

pressions as well as legibility. White text on a black background should usually be larger than traditional black text on a white background. Fine lines in a Roman type style may sometimes almost “disappear.” It is better to use a sans serif type when the text is white on a black background.

See the sub-section *Legibility of colour* in the chapter *Functional principles,* and the section *The message on the screen* in the chapter *Screen typography*.

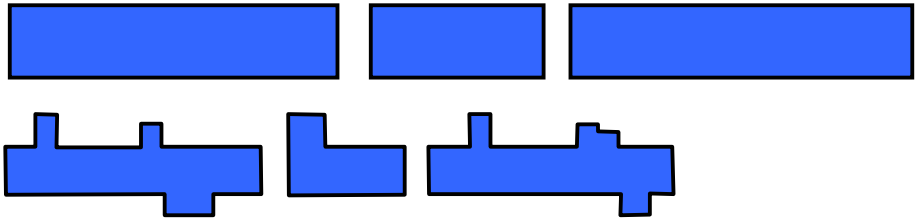
Stylistic variation of type

With respect to line thickness, inclination, and width characters in a typeface can be drawn in many different versions. The major examples of stylistic variation of regular text are **bold**, *italic*, and ***bold italic***. The visual weight and visual impression varies a lot. It may be compared with physical weight. A small and extra bold and expanded character may be seen as heavier than a large, light and condensed character.

A typeface may be available as light condensed, light, light expanded, bold condensed, bold, bold expanded, regular condensed, regular, regular expanded, extra bold condensed, extra bold, and extra bold expanded. With respect to inclination a typeface may be designed in italic letter style versions. A typeface may also be available as outlined, in-lined, and shadowed.

Regular type is easier to read than uncommon type. Boldface or italics should normally not be used for continuous text. Italic print is read more slowly than regular type and is also disliked by many readers (Tinker, 1965). However, boldface and italics may be used for emphasis. Italics may be used for small parts in a running text, for headings, and for captions. Bold type may be used for headings.

Different style manuals have different recommendations for when italic and bold type versions should and shouldn't be used. The use of underlining and all capital letters should be restricted to headings and titles, if they are used at all. Usually bold and italics are quite sufficient. Make type big enough to stand out from the background and heavy enough to be visible (Lipton, 2007). Underlining in the middle of a sentence makes the lower line more difficult to read (Isaacs, 1987). Shadow and outline letters should be avoided.



Words in all capital letters have similar shapes and profiles. The three words "DESIGN FOR CLARITY" (at the top) cover rather similar areas. However written with lower case letters (at the bottom) the words "design for clarity" look quite different. (This illustration is based on Futura.)

Reading speed can be substantially reduced when italic text is used for continuous prose (Foster and Bruce, 1982). Extensive use of italic text in continuous prose will impair their functions to emphasize (Glynn, Britton and Tillman, 1985).

The most common type versions are easier to read than uncommon type versions. We should avoid odd type versions like outline, shadow, and reverse type like white type on black background. Boldface and/or italics should not be used for running text but rather for emphasis of important parts of the text. Ty-

pography can be used to modulate a message. Lund (1999) reviewed research literature on the legibility of seriffed and sans serif type and concluded that the research is not only inconclusive, but it is mostly of too poor a quality to be relied upon. Other aspects, like lighting condition, and size of type are more important for legibility. For continuous reading, the typeface must be comfortable to read for longer periods of time.

We should remember, though, that content is more important than form. A text will retain its content even when type design is changed. Graphic design can be and should be used to build consistency and aid communication. Glynn, Britton and Tillman (1985) reviewed studies on the effect of "typographic cueing" on learning. Typographic cueing generally refers to the use of bold or italic type or underlining to signal the important ideas in a text. There is little doubt that cueing does work in drawing attention to the cued material. The consensus is that readers are more likely to remember cued ideas than un-cued ideas (Hartley, 1987).

The angle of the thickest part in a curved letter is usually described as either diagonal or vertical. It can also be horizontal. This design feature is called *stress of a typeface*. For example the typeface Sabon has diagonal stress, and Century Schoolbook has vertical stress. Stress reminds of the visual properties of writing. It is easy to see the angle of stress by drawing a line through the thinnest points of the letter o. There is no obvious stress in a sans-serif typeface with uniform strokes.

Typeface personalities

Several scholars have discussed the physical characteristics that lead to "perceived personas" and "typeface personalities" of typefaces. According to Hassett and Curwood (2009, p. 272) the

use of font is a mode of communication that serves as a semiotic resource. Research indicates that the presentation of texts affects the perception of the contents of the message.

Krause (2007) and Samara (2007) have offered different conceptual categories in their taxonomies of fonts, including moods, concepts, energy, elegance, technology and specific areas. Machin (2007, p. 87) noted that "letterforms themselves have become more important as part of the overall meaning of composition and have themselves become more graphic and iconic." Typographical features like colour, flourish, formality, framing, size, slant, and weight focus on elements of characters as well as overall composition. Strategies that support how readers interpret multimodal texts are evolving (Albers, 2008; Anstey & Bull, 2006; Serfini, 2010; Serafini and Clausen, 2012).

Several typefaces elicit strong emotions from groups of viewers. One example is Comic Sans. This typeface was designed for Microsoft based on lettering from comic books, but it has been used in many other situations. Depending on your point of view, Comic Sans is fun, breezy, silly or vulgar and lazy – and many graphic designers and aesthetes just hate it (Steele, 2009).

Viewers judge the material based on the visual attributes versus the meaning of the text (Childers & Jass, 2002, p. 95). To ensure that the intended message is understood, document designers must consider how typography and text present a united message.

There are many different and subjective opinions regarding the personalities of typefaces. With *serif type* it is easy to follow text lines (Tinker, 1963). *Sans serif type* is seen as clean, modern and technical (Brumberger, 2003).

Light type has been described as delicate, gentile, and feminine (Brumberger, 2003), as difficult to read and unprofessional (Mackiewicz, 2005), and as insubstantial and timid (Van Leeuwen 2006). *Moderate weight type* has been regarded as professional (Mackiewicz, 2005).

Bold type has been seen as aggressive, masculine and strong (Brumberger, 2003), as difficult to read and unprofessional (Mackiewicz, 2005), as assertive, daring, domineering, overbearing, solid and substantial (Van Leeuwen, 2006), as daring, overbearing, stable and substantial (Machin, 2007).

Van Leeuwen (2006) described *narrow and condensed type* as precise, economical, cramped, and restrictive. Machin (2007) described them as cramped and un-assuring. *Expanded type* was regarded positive light, and providing room to breathe (Van Leeuwen, 2006).

Cursive type fonts as well as *script fonts* are seen as elegant (McCarthy and Mothersbaugh, 2002), or organic, personal, and formal (Van Leeuwen, 2006). *Angular type* conveys cultural meanings. It is abrasive, brisk, controlled, decisive, harsh, masculine, modern, rational, and technical (Van Leeuwen, 2006). *Curvature* in type is perceived as fluid, gradual, maternal, natural, organic, smooth, and soft (Van Leeuwen, 2006).

According to Van Leeuwen (2006) a *flattened type* has heaviness, inertia, self-satisfaction, and solidity. A *vertical type* has instability, lightness, and an up-wards aspiration. Mackiewicz (2005) regarded *imperfection* in type as friendly. Abe Pittman (2012) concluded that regardless of the ability to communicate technical features of a typeface's anatomy, viewers share an emotional reaction. When selecting typefaces it is important to consider the amount of text, purpose, intended audience and medium.

Van Leeuwen (2006, p. 142) concluded that a new typography has emerged. Typography is no longer a humble craft and an "abstract art" in the service of the written word. It is a means of communication in its own right and it is spearheading innovation in graphic design.

Moys (2011) studied how typography and layout in a selection of magazine feature spreads and covers influenced reader's judgments. When it came to typeface participants in the study "were more likely to discuss its treatment than its choice: whether something was in bold, capitals, italics, colour, had a drop shadow or other effects, seemed to influence its distinctiveness far more than the choice of typeface." Moys concluded that "typographic voice" is conveyed through a range of variables. It is not just a question of establishing a typographic or visual mood. Typography plays a role in how a document is seen to address its readers and position itself.

Selection of typefaces

The decision of which typeface to select should rest largely on the purpose and on the intended audience for the document (Benson, 1985; Black, 1990). Using the correct typeface for the job is based on solving a problem and meeting a need.

Lenze (1991) noted that *private documents* may invite the use of ornate and stylish looking fonts. *Professional documents*, however, require maximum legibility (Benson, 1985; Pettersson, 1989; Tinker, 1963).

Advertisements must be noticed. Therefore, it is important to choose a graphical form that arouses interest. Thus, unusual typefaces can be useful and stimulate attention, entice the reader to look at the pictures and begin reading the text.

When it comes to *information materials*, the graphical form should basically be simple and "transparent" and not arouse any special interest or attention for its own part. The graphical form should not be too exciting or provocative, nor should it be patently dull. McDougall and Hampton (1990, p. ix) concluded that design and layout should enhance visual and verbal content by making it appealing and understandable. It should not be excessively ornamental, thus calling attention to itself.

To encourage readers to pay attention to relevant information, text designers should help the reader to control his or her cognitive processes during learning (Mayer, 1993). To achieve optimum legibility it is known that:

- Common typefaces are easier to read than uncommon typefaces (Benson, 1985; Paterson & Tinker, 1932; Spencer, Reynolds & Coe, 1974; Tinker, 1963, 1965).
- Serif typefaces are often considered to be easier to read than sans serif typefaces, except for small letter sizes (Tinker, 1963).
- Running text should have a "normal" combination of upper and lower case letters. All-capital printing has been shown to markedly reduce the speed of reading (Henny, 1981; Poulton & Brown, 1968; Tinker, 1965).
- Without sufficient white space around words in all capitals, the words will become too difficult to read (Kinney & Showman, 1967).

The different typefaces have their individual characteristics. They vary in space and in their visual appeal. Some are more legible and some are less legible. In the USA children usually learn to read using textbooks with serif typeface like New Cen-

tury Schoolbook. In European countries it is not unusual that sans serif typefaces are used in textbooks. Children in China learn to read the complicated Chinese characters. And we can find equally good readers in all these countries. As a matter of fact, the reader should never become too conscious of the typeface.

Type can be created in a variety of styles. A change in type style can signal a change of purpose, a new section, or another degree of importance. Typographical techniques can alert learners to such things as main ideas, important concepts, rules, sections, subsections, and more. However, multiple type styles on a page tend to be confusing rather than facilitating. The decision of which font or which fonts to use should rest largely on the purpose and audience of the document (Benson, 1985).

Systems for desktop publishing are now common. Software that is easy to handle give the layman the opportunity to combine verbal and visual messages. This technological revolution enables us to do anything we have in mind to do on a page or on a screen. The mechanical processes of typesetting and makeup do no longer restrict us. Unfortunately, most desktop publishers know little about typography, graphic design, and information design. With the new systems it is almost too easy to manipulate a text and make use of all the possibilities to change the appearance of a page.

It is far too easy to create confusion or even a complete mess-up. As White (1987) put it: “The distinguished art and craft of typography developed over centuries by sensitive craftsmen/artists cannot be handed over to an indifferent typist keyboarding a machine (however marvellous the technology) with results of equal excellence and stature. The reader feels the difference in terms of the piece’s ease of reading, charm, and

comfort." It is wrong economy to cut back on investment in quality, believing the readers won't know the difference. Winn (1993) noted that in text, attention is drawn to words or passages that stand in contrast to the rest of the body of the text.

Baggerman (2000, p. 69) pointed out that designers make a frequent mistake when they choose typefaces according to their own tastes instead of according to the needs of the users.

Some common typefaces

A "good" typeface might actually be one that is more or less "invisible" to us as readers (Goldenberg, 1993; Scieszka, 1998; Melin, 2011). We shouldn't be too concerned with the design of the typeface. The typefaces in common use are all more or less equally legible (Paterson and Tinker, 1932; Tinker, 1963, 1965). However, readers are likely to have strong preferences about the aesthetics of typefaces. One important aspect of the design of a typeface is the perceived size of the individual characters. Some type looks big and some type looks small. This depends on the design of the characters and their x-height.

Next to the x-height, the shaping of the various letters is important. The counters are important for printing and also for the recognition of words. In desktop publishing all parts of the letters must be clear and distinct. Clear contrasts increase the legibility, uniformity reduces it. A typeface can influence our appraisal of a printed message. Thus, it might be important to make a choice so that typography reinforces the message.

As mentioned earlier, thousands of fonts are available. In the practical work with graphic design for information, we need only a few typefaces in different versions. Times New Roman was created for the London newspaper The Times. Today Times

New Roman is available in most computers and used in a large number of documents.

Common font families like Baskerville, Berling, Bookman, Garamond, New Century Schoolbook, and Palatino can be used successfully for the body text in books. Modern newspaper typefaces include Stone (1987), Swift (1985), Gulliver (1990), and Utopia (1989). These are all serif typefaces. Like Times New Roman they have large x-heights and good legibility.

The following pages present some examples of the same text segment rendered with different typefaces.

Georgia

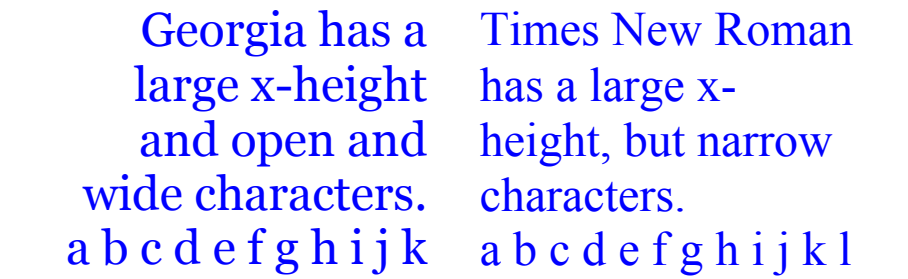
The type designer Matthew Carter created the two typefaces *Georgia* and *Verdana* for the Microsoft Corporation. They were released in 1996.

Georgia is a transitional serif typeface specifically designed for clarity. It is similar to Times New Roman, but it is larger at the same point size. Georgia has a large x-height and open and wide characters. Thus Georgia has good legibility on computer screens, even at small sizes. Times New Roman is narrow with a more vertical axis. Serifs in Georgia are almost horizontal, more blunt and wide. The Georgia typeface is very common for running text in documents at the Internet.

Georgia: abcdefghijklmnopqrstuvwxyzABCDEFGHIJKLMNOPQRSVWXYZ,.;:!?”()/&%+-=><*1234567890

Infology is the science of verbal and visual presentation and interpretation of information. On the basis of man’s prerequisites, infology encompasses studies of the way a verbal and visual representation should be designed in order to achieve optimum communication between sender and receiver. Infology models

contain both theoretical (descriptive) elements and normative (prescriptive) elements.



In this illustration Georgia is compared with Times New Roman in the same type size.

Helvetica

The Swiss typeface designer Max Miedinger created *Helvetica* in 1957. Helvetica has endured over time as an example of a clean, durable, malleable, rational, and universal typeface. This all-purpose font is everywhere, particularly in commercial use representing all kinds of brands. It is the ultimate design of the Bauhaus–Swiss–International schools. Helvetica is designed with simple, striking lines in a compact way. Like Times, Helvetica has been developed in many typefaces and font versions. Helvetica typefaces are very useful for captions, headings, tables, and titles, but they might be hard to read in running text. The similarities between upper case I and lower case l cause real problems in words like “Illustration” (See the illustration at *Verdana*). Running text in Helvetica will need extra space between the lines. Helvetica is often used for reader slides, overhead transparencies and in business graphics. According to Collier and Cotton (1989) Helvetica typefaces may be the most

widely used sans serif typefaces in the world today. In this book Helvetica has been used for labels and captions within figures.

Helvetica: abcdefghijklmnopqrstuvwxyzABCDEFGHIJKLMNOP QRSVWXYZ,.;:!?”()/&%+-=><*1234567890

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Times New Roman

The British type designer Stanley Morrison created the original *Times New Roman* for Monotype in 1932, to be used in the London newspaper *The Times*. He worked together with Victor Lardent, an advertising designer and draftsman at The Times The mission was to produce a new, first-class and easy-to-read typeface with very good legibility even in small sizes for the newspaper. The production methods for The Times newspaper were far above the world standard at that time. Times New Roman was designed for hot-metal print and the rotary letterpress printing. Times New Roman combines the classic elegance of typefaces for books with modern demands for economy of space. Several versions of Times New Roman have been developed. Typefaces and fonts belonging to “the Times family” are all easy to read. They are probably the most widely used serif typefaces in the world. Times typefaces are used in newspapers and magazines as well as in books. However, Times New Roman

cannot be successfully used on computer screens, and laser printers cannot print the fine lines in small letter sizes.

Times New Roman: abcdefghijklmnopqrstuvwxyzABCDEFGHIJK LMNOPQRSVWXYZ,.;:!?”()/&%+-=><*1234567890

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Verdana

The type designer Matthew Carter created *Verdana* as a humanist sans-serif typeface for computer screens. It was specifically designed for clarity. Verdana has no serifs, large x-height as well as open and wide characters. The spacing between characters is loose. In contrast to Helvetica similarly shaped characters have emphasized distinctions. Thus Verdana has good legibility on computer screens, even at small sizes.

Comparisons between Helvetica, Georgia and Verdana.

Typeface	*Digit 1*	*Lowercase l*	*Uppercase I*
Helvetica	1	l	I
Times	1	l	I
Verdana	1	l	I

Verdana is very useful for titles, headings, captions, and tables of various kinds but it might be hard to read in running text. However, in 2009 the international furniture company IKEA

changed the typeface in its catalogue from the classical typeface Futura to the modern Verdana. The company expressed a desire to unify its branding between print and web media.

Verdana: abcdefghijklmnopqrstuvwxyzABCDEFGHIJKLM NOPQRSVWXYZ,.;:!?”()/&%+-=><*1234567890

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Paper and ink

In all graphical media the quality of the paper and ink is of vital importance for the final result. The paper has its specific bulk, finish, grain, texture, and weight. It may be stiff or floppy. It may be glossy and shining or matte and maybe dull. It may be thick or thin. Thin lines, in serifs on small type sizes, may require a harder paper than normal lines and larger type. The printing technique used will affect the type of paper needed. The quality of ink is also an important factor in graphical communication.

All these factors affect legibility and our reading comfort and also our perceived value of the product. The degree of contrast between the colour of the ink and the colour of the paper should be optimum. For text printed in black all paper surfaces are equally legible if they have a reflectance of at least 70%. The most legible combination is a black text on a light yellow back-

ground. In a normal reading situation, black print on white paper is over 10% more efficient than white on black (Pettersson, 1991).

Cost effective typography

If a document is to have many readers who will try to read and understand it during working hours, the cost of reading the document will be the greatest expense it incurs. Even though it may be expensive to produce information, it usually costs even more to store, access, and use it. Therefore, the more people who will partake of certain information, the greater the total cost will be. Because the cost of reading is closely linked to the type of material in the document and to the various groups of readers it targets, there will be great opportunities to reduce the total costs and save money by presenting the information in a suitable fashion.

To facilitate our work with cost effective typography and graphical form, we may need a number of guidelines, or rules of thumb. In an international organization such as a multinational corporation advice and guidelines may be developed according to the following criteria and requirements:

1. The text must exhibit good legibility. Because the typography should provide ease of reading without being “visible” (that is, without arousing notice), we must avoid unusual typefaces.
2. Our point of departure should primarily be the reader's psychological capacity for perception, and secondly the potential performance of the technical equipment at hand.
3. It should be as easy as possible for technical writers and editors to handle templates for graphical forms. Thus, these

people should be given the necessary training to handle computer programs and the like where these templates are available.

4. Size ratios in typography and layout should be based on conventions of typography and on research findings in perception psychology.
5. The typography and layout should be acceptable in many countries, even though national tastes may vary widely.
6. The typography should be adapted to the technology, that is, it should look good when printed on a laser printer, and when copied on an ordinary office copying machine. Look for, and adopt to the week part in the production chain.
7. The typefaces should be available as standard selections in computers and laser printers all over the world. Even so, we have to accept the fact that printouts made by different printers will not be identical in appearance.
8. The typography should usually be "economical". It should be possible to accommodate a great deal of information in a limited space without a crowded appearance.
9. We should choose typefaces with high x-height for good legibility, even when small type sizes are used.
10. The typography and layout should produce good results on standard paper. In Europe, the standard paper size is A4 (210 x 297 millimetres), whereas in the USA, US letter (216 x 279.5 millimetres) is the standard. We deal with these differences by varying the margins on the page.
11. The dimensions of pages and length of lines are given in centimetre or millimetres. Type sizes are given in "points," the typographical unit of measurement. Note that there are different systems in USA and Europe. In the Pica system 12 points = 4.2333 mm. In the Didot system 12 points = 4.511

mm. In the Mediaan system 12 points = 4.205 mm. The most common programs for desktop publishing use the Pica system, giving points as “pts”.

12. It should be possible to print a document and insert the pages directly into a loose-leaf binder. This means that right-hand and left-hand pages should have the same appearance, basically a right-hand page layout.
13. If a document is to be reproduced using conventional technology, it should be possible to use printouts of it from a laser printer or from a phototypesetter as a basis for direct reproduction. When A4 is reduced to 80.4%, the result conforms to the conventional printing format, G5 (169 x 239 millimetres).
14. Before conventional printing, the layout of right-hand and left-hand pages may easily be changed.
15. All documents might be coded in accordance with the SGML standard, so that it is easy to use the information in different ways, and in different formats. Sometimes other standards may be used (like HTML, and XML).
16. Reduction through successive refinement is the best way to reach clarity. To create an elegant solution, anything that is not essential to the communication task has to be removed.

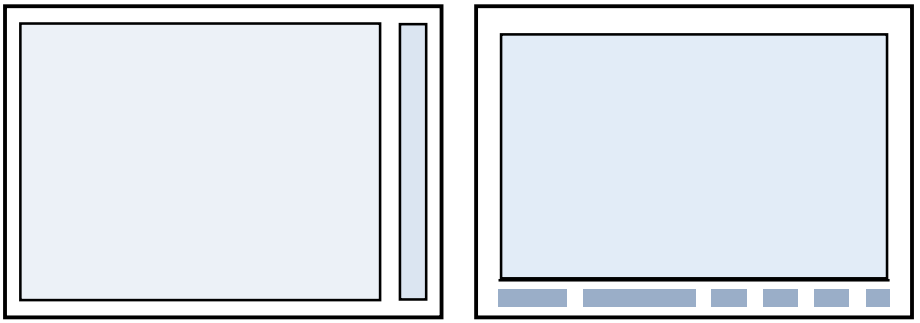
Projected typography

In audio-visual instruction and in audio-visual materials, such as overhead transparencies, slides, filmstrips, and computer-based presentations, lettering must be considered carefully in order to improve legibility. Type must be large as well as bold enough to see. In verbal presentations, many of the projected images consist only of text. In written documentation, this type of information should be worked into the body of text instead.

(See the book *Information Design 2–Text Design* for more information about oral presentations and the use of projected images.)

OH and PP

According to the standard for OH, overhead transparencies, SIS 62 23 01 SD A4L, the actual plastic film is 210 x 297 mm. The picture surface is 190 x 245 mm, which is a height-to-width ratio of 1:1.289. Administrative data are put in the 35 mm right margin. The top margin is 15 mm, bottom margin 5 mm and left margin 17 mm. In some organizations there is a need for more administrative data, such as logotype and/or name of the organisation, name of author, document name, security classification, revision, publication date and document number. These data are put in the bottom margin. Here the picture surface may be 170 x 270 mm, which is a height-to-width ratio of 1:1.588. In PowerPoint the height-to-width ratio is 1:1.328. The size of the image can be adjusted to the situation on the computer screen.



The layout to the left is the OH-standard SIS 622301 SD A4L. The layout to the right is used in some organizations. This layout can also be used for PP and other similar systems.

Many speakers use text transparencies, or "word-visuals," containing key words in attempting to supply an overview, clarify, reinforce, and summarize complicated arguments. These texts must then be brief and concise. They must also be easy to read. For good legibility, characters should be large, distinct, and bold, not less than six millimetres high when projected in a room the size of a normal classroom. Larger rooms require larger character sizes.

Normal text, containing both uppercase and lower-case letters, is easier to read than texts using only uppercase letters. Overhead transparency texts should usually consist of black characters on a light background. Text transparencies are a useful adjunct for a speaker but are sometimes very boring to an audience. In verbal presentations, many of the pictures consist only of text. For good legibility of projected text we should consider the following aspects:

- Use no more than six rows of six words each in one overhead transparency. The line distance should consist of the size of the typeface plus 15 to 20% of extra white space.
- Maintain a good contrast between foreground and background. Good colour combinations are yellow – black, and white – blue.
- Avoid graduated and tonal background fills.
- Overhead transparencies should preferably be horizontally presented.
- Overhead transparencies should be projected in a correct way and not in any way distorted.
- Text should have maximum legibility. It may be a good idea to use a linear typeface such as Helvetica or Verdana; for ex-

ample 36 and 30 points for headings, 24 points for the body text, and 18 points for texts within illustrations.
- Text must also be legible to spectators who are sitting at the rear of the hall. The minimum size of letters in overhead transparencies is six millimetres (Helvetica or Verdana 18 points).
- Restrict stylized and fancy typefaces to opening slides.
- Edit the text into sections that are easily read.
- Be consistent in the use of uppercase and lowercase letters.
- Text should usually be left justified.
- White – yellow, red – green, and red – blue are all very bad colour combinations.
- A good general guideline for reader slides is to use a light or a dark background colour appropriate to the content, and then use a colour with good contrast for the text.
- Put the necessary identifications data on each transparency.
- Check the spelling.

In written documentation, this type of information should be worked into the body of the text instead. Basically the guidelines for overhead transparencies are also relevant for PowerPoint presentations, and other similar systems.

Slides

A slide's subject should appear against a black background. Text slides should only be used to a limited degree. Texts should be light (white or yellow) on a dark background (black or dark blue). Many colour combinations are hard or even impossible to read on a screen.

According to the standard for 5 x 5 slides, SIS 62 23 03, the individual part of the film is 24 x 36 mm. The picture surface is

22,5 x 34,5 mm, which is a height-to-width ratio of 1:1.533, which is quite close to the golden mean (1:1.618). The actual frame is 5 x 0 cm.

In verbal presentations, many of the pictures consist only of text. We should consider the following aspects for good legibility:

- Use no more than six rows of six words in each image, set in a linear typeface, with characters large and bold enough.
- Maintain a good contrast between foreground and background. Good colour combinations are yellow – black, and white – blue.
- Avoid graduated and tonal background fills.
- Slides should preferably be horizontally presented.
- 15 – 20 words on a slide is maximum for effective communication.
- Letters should be medium to medium-bold.
- Lettering height should be no less than one 25th of the height of the artwork to be transferred to film.
- Upper-case letters are often used in slides. Be consistent in the use of uppercase and lowercase letters.
- Restrict stylized and fancy typefaces to opening slides.
- Edit the text into sections that are easily read.
- Text may be centred.
- White – yellow, red – green, and red – blue are all very bad colour combinations.

Screen typography

Compared with traditional graphic presentations, a presentation of information on visual displays such as television sets and computer terminals is very limited. Still, information may be presented in many different ways.

Visual displays

Visual displays can be built in many ways. A colour television set, an advanced computer terminal, and a liquid crystal display all have different characteristics. A television set is built to be used at a distance of more than 120 centimetres. A computer terminal, however, is built to be used at a distance of 60 centimetres and has a much better picture resolution than a television set. Our perception of text and pictures on visual displays are, of course, to a large extent dependent on the quality of the screen. A videotex terminal simply cannot reproduce a simple illustration like a pie chart, since the resolution is only a total of about 5,000 graphical elements.

Computer terminals are often built with a screen resolution of 72–82 dots per inch. Today, an ordinary television image consists of about 250,000 image points, or picture elements, which vary with respect to both grey scale and colour information. High Definition Television (HDTV) uses 1,125 scanning lines and can contain five or six times more information than the present NTSC standard colour television system, with 525 lines. (The European PAL-system has 625 lines.) HDTV developments of flat PAL 625 screens will also give increased technical possibilities to present text and pictures.

However, visual displays will continue to have a resolution far below a printed page. Some laser printers produce documents with 1,200 dots per inch horizontally, and 600 dots per

inch vertically. Phototypesetters produce 1,250–2,600 dots per inch. This is enough to create very small and close raster dots and to produce very fine lines in the final print.

Colour displays

In discussions on technology, colour is related to measurable amounts of light. In 1931 an international body called the Commission International de l'Eclairage (International Commission on Illumination), or CIE, defined standards of light and colour. In this context colour primaries are the basic colour stimuli used for the synthesis of any colour, by addition or subtraction. Additive combinations of a very limited amount of radiation are used for colour synthesis of a range of colours in a cathode ray tube (CRT) and in a visual display unit (VDU).

A colour CRT is a vacuum tube, enclosing one or three electron guns for generating beams of electrons, a system for focusing the beam to produce a spot of visible light at the point of impact on the phosphorous screen, and for electric field deflection of the beam, suitable deflection electrodes. The thousands of small phosphorous dots are grouped into threes, called triads, with one dot emitting radiation that appears red, one dot emitting radiation appearing to be green, and the third emitting radiation appearing to be blue. Red, green, and blue are called the "three primaries," RGB. One lumen of white is given by 0,30 red + 0,59 green + 0,11 blue. Any two primary colours may be mixed to produce other colours. Red and green added can produce a range of hues around yellow. Green and blue produce a range centred on blue-green, while red and blue mixtures produce a red-blue range. The total number of colours that can be produced in a CRT depends upon the number of steps or grey levels obtainable for each phosphorous dot. Advanced systems

are capable of producing up to 256 simultaneously visible colour stimuli chosen from a palette of 16 million. However, in most cases only a few colour stimuli are needed at the same time.

The uncertainties in the coordinates of colours are rather large as a consequence of the heterogeneous distribution and efficiency of the phosphorous over the screen, the defects in electron beam convergence, and the departures of the relations between the values of the colour signals and the digital counts. One consequence of additive combinations in colour television is that characters presented in white (the three-colour combination) are less sharp than those presented in yellow, blue-green, or red-blue (all two-colour combinations). In a similar way, the latter colours are less sharp than red, green, and blue (pure colours). Sometimes colour rims may be seen at the characters with two- or three-colour combinations. The additive combination starts in dark adding light to produce colour. Thus, another consequence of additive combinations is that secondary colour stimuli will always appear brighter than the primaries.

Luminance is a photometric measure of the amount of light emitted by a surface (lumen/steradian/sq.m.). Radiance is a radiometric measure of light emitted by a surface (watt/steradian/sq.m.). It should be noted that neither luminance nor radiance is the equivalent of brightness, which is the experienced intensity of light (bright-dull). In colour displays it is very difficult to distinguish brightness from lightness (white-black). When the signal to the display is increased, the brightness of the total screen is increased. If a signal to a specific part on the screen is increased, the lightness of the area is increased compared to the total screen.

It is usually possible in a CRT to adjust the luminance, the hue, and the saturation. Like brightness and lightness, hue and saturation are also psychological dimensions. Hue is the basic component of colour corresponding to different wavelengths. Saturation is most closely related to the number of wavelengths contributing to a colour sensation. We should always remember that the production of colour, by additive or subtractive methods, has nothing to do with the actual perception of colours.

In a CRT some 8,000 to 20,000 volts of tension are required to form an image on the screen. Screens with several colours even require up to 30,000 volts. The electrostatic field of the CRT is positively charged. Thus the person sitting in front of the screen is negatively charged and a strong field is created. The field affects the movement of dust particles in the air. Since the majority of the particles are positively charged, they are attracted to the operator. The rate of deposit can reach 10,000 particles per square millimetres of skin an hour. Thus skin and eyes become irritated. People suffering from allergies can experience extreme discomfort. The electrostatic field can be eliminated with the help of a grounded filter, mounted on the screen.

The large magnets used to focus and direct the electron beam on the screen create the electromagnetic field. The electromagnetic radiation consists of two components of which one can be shielded. It is not clear as to whether this radiation affects the adult human body unfavourably. However, it is known that this radiation might be injurious to unborn children when pregnant women work too many hours in front of the screen.

Interface design

A human-computer interface is a communications channel between the user and the computer. An interface includes both 1) physical components, and 2) conceptual components. Physical components are devices for input and output of information. Input devices include microphone, touch panels, joysticks, speech recognizers, eye trackers, and data gloves. Output devices include visual displays and sound or speech synthesizers. Conceptual components include command languages, menus, and typography and screen layout.

Interface design is interdisciplinary. It may involve facts from psychology, computer science, information science, engineering, education, and communications. The information processing model of cognition is used in cognitive psychology. It establishes that: 1) our working memory is limited to five to seven "chunks" of information; 2) our attention must frequently be refreshed; and 3) recalling information requires more cognitive effort than recognizing information. Novices and casual users prefer menus to command languages, recognizing an option is easier than remembering a command. Touch panels in information kiosks and graphic displays in most video games overcome many psychological limitations. They share the “load” between physical and cognitive activity. Immediate feedback and easily reversibility invite user exploration.

The psychological theory of mental models, or schemas, has also been applied to interface design. Users develop mental models for objects, events, and ideas. These internal representations are incomplete and often inaccurate, but they help people deal with their systems.

A common approach in interface design is to define metaphors that links existing user knowledge to the functions of the

system. The desktop metaphor may be the best known example. However, a more fundamental metaphor is the screen as a scroll of paper. Metaphors are useful, but they can also constrain the user's view of the system. Concern with ease of learning can eventually interfere with skilled use.

Research in psychology has led to a number of principles for better interface design. Perhaps the most basic principle is that an interface should be designed around the needs of the user rather than added on after a system has been completed, thus serving the constraints imposed by the system. Marchionini (1991) provided the following seven design principles:

1. The interface should compensate for human physical and cognitive limitations whenever possible. However, the interface should be "transparent," not getting in the way of the user's actions or impeding his or her progress. The interface itself should not overload the user with complexity or unnecessary "bells and whistles" that interfere with or distract from the task at hand.
2. The physical components of the interface should be ergonomically designed, taking into account the comfort and health of the user as well as his or her special needs and characteristics. For example, a touch panel design for a word processing program demands far too much arm movement for lengthy sessions, but serves quite nicely in an information kiosk of a shopping mall when positioned to be touchable by users of various heights.
3. The interface should be consistent. For example, selection methods, positioning of important text and buttons, text fonts and styles, and window layout and management should be consistent in all parts of an interface.

4. Non-command interaction styles such as direct manipulation and menus are preferable to command languages, although the expert user should be given “type ahead” capability to quickly move through layers of menus.
5. The interface should handle errors by providing simple and concise error messages that assist the user in recovery and future avoidance.
6. The interface should support reversible actions (e.g., the UNDO capability in many systems).
7. The interface should be subjected to usability testing early in the design process and as each iteration of the product evolves.

Computer systems are becoming increasingly interactive, and this trend will continue as new interfaces are developed. Interactivity will be supported by new input and output devices that take fuller advantage of the many communication channels humans employ. The development of interfaces that support multiple input and output devices in parallel will be important. For example an interface that accepts voice and gesture concurrently will give richer control to users who must move about while controlling systems. Likewise, video and sound output together provide a more powerful communication channel for information flow. Intelligent agents are also under development. Agents can be assigned specific tasks by the user and then sent out to execute those tasks.

The message on the screen

The message on the screen may consist of text, numeric data, and visuals. The layout of the message is important for our perception.

Text on the screen

The quality of visual displays is important for our perception. Colour as well as blank space are essentially free and might be used to increase legibility. Experiments with 11,000 judgments of perceived reading efforts of text on visual displays (Pettersson et al., 1984a) showed that colours presented on colour displays are ranked in the same order as surface colours in traditional print media. Blue was most popular. The best combination is black text on a white or yellow background. Black was also the best background colour, because it has good contrast to most text colours. However, the background colour of a computer screen should be "fairly light" or "fairly dark," depending on the content (Bradshaw, 2001). The text displayed on a screen should have an opposite ("fairly dark" or "fairly light") colour. When the screen resolution is average or poor, sans serif is more legible (Bernard et al., 2001).

A presentation of text on a visual display depends on the type of characters used, the design of the information, the background, and also the content. The characters may vary with respect to font, size, lowercase and uppercase letters, colour, and contrast to the background. Legibility of the text depends on the execution of the individual character and the possibility for each one to be distinguished from all others. People generally perform better with text on paper than with electronic text (Dillon and McKnight, 1990).

The most important consideration when working with typography and colour for computer screens is to achieve an appropriate contrast between text and its background (Carter, Day and Meggs, 2007). They wrote (p. 80): "It has long been considered that black type on a white background is the most legible (combination). While this combination remains an excellent

choice, other alternatives may offer equal if not improved legibility due to improved digital and printing technologies, and the fact that colour is a relative phenomenon. ... Generally, all legibility guidelines related to working with colour and type in print apply also to type appearing on a computer screen." It is also important to use typefaces specially designed for screen display, such as Georgia, Trebuchet and Verdana (Bias et al., 2010; Hoffman, White & Aquino, 2005; Josephson, 2008).

Subjects generally prefer reading text on paper to reading electronic text on a screen (Dillon & McKnight, 1990; Wright & Lickorish, 1983). People perform slower and less accurate on instructional tasks when they have to read from computer screens and not from paper (Wright & Lickorish, 1983). Proofreading of text from print on paper is 20-30% faster than proofreading from computer screens (Gould & Grischowsky, 1984). A lot of work has been conducted to create legible characters. Knave (1983) has given guidelines for the creation of characters. A minimum of ten to twelve raster lines per character is required. When characters are built by dots in a dot matrix, the characters will be round or square and not elongated. A dot matrix of seven by nine dots is often regarded as a minimum. The height of the characters should be a minimum of four millimetres for a viewing distance of sixty centimetres.

Subjects dislike fast scrolling text on computer screens (Burg et al., 1982; Kolers, Duchnicky & Ferguson, 1981). For maximum legibility on a computer screen double spaces should be used between lines in a continuous text (Grabinger, 1989; Kolers, Duchnicky & Fergusson, 1981). Blinking and flashing text can be used as an accenting (Rambally & Rambally, 1987).

General design rules should be employed also in the design of screen displays. Thus material should be arranged and dis-

played so that it is easy to read, from top to bottom and from left to right. A visual display design may vary with respect to spatial organization like headings, length of lines, justification, spacing, number of columns, number of colours at the same "page," and directive cues like colour coding, twinkling characters or words, and scrolling text. Experiments (Pettersson et al., 1984a) with 11,000 individual judgments of perceived reading efforts of text on visual displays were concluded as follows: Colours presented on colour displays seem to be ranked in the same order as surface colours in traditional print media. Blue was most popular.

- When text is shown on a visual display, there is no easily read colour combination. About thirty-five of one hundred and thirty-two combinations are acceptable.
- The best text colour is black, which causes good contrast to most background colours.
- The best combination is black text on a white or yellow background.
- A text can be easy to read in any colour, provided the background is carefully selected.
- The best background colour is black, which has good contrast to most text colours.
- Reading efforts of colour combinations are independent of the sex of the subjects.
- There was no difference between colour blind (red-green) users and users with normal vision.

Inverse writing in various colours within a text may be used to achieve emphasis. Other possibilities may be a box around a paragraph or a change in font or size of letters. Blank space in printed material increases cost, since more paper is required.

Thus, it is not used often. However, colour as well as blank space on a visual display is essentially free and might be used to increase readability. Full text screens in several colours are difficult to read and quite annoying. What about double spaced lines and/or spaces between columns? As stated above, it is possible to make rather clear statements with respect to the use of colours. However, it is not as easy to give guidelines for the other variables.

Studies of attitudes to various variables (Pettersson et al., 1984b) in the presentation of text on visual displays showed that subjects dislike fast scrolling text. This was also found by Kolers, Duchnicky and Fergusson (1981), and by Burg et al. (1982). Subjects seem to dislike more than three or four text colours on the same "page". They seem to consider colour coding and/or twinkling text to be a good way to show that something is especially important.

Subjects also seem to agree that text in uppercase letters is harder to read than normal text. According to Kolers, Duchnicky and Fergusson (1981), and Grabinger (1989) we should use double spaces between lines in a continuous text for maximum legibility. Attitudes are indifferent to a few design variables. Thus text on every second line does not seem to make it easier to read than text on all lines. Higher characters do not seem to be easier to read than standard characters. Half lines do not seem to be better than full lines. A two-column layout does not seem to be better than a one-column layout.

Other research suggests that margins should neither be narrow nor very wide. Rambally and Rambally (1987) showed that blinking and flashing of a text on a computer screen is an accenting technique that will grab the attention of the user.

The background may vary with respect to colour and brightness. Good combinations of text and background colours always have a good contrast. Optimum contrast is often found to be 8:1 to 10:1. Most subjects prefer a positive image, i.e., dark text on light background with a minimum refresh rate of 70 Hz.

CLEA-research (Pettersson, 1984) concerned with perceived reading efforts of text on visual displays and altering colours of the actual equipment found that the close context is really important for the perceived reading effort. The colour of a terminal should be rather subdued. The best of ninety combinations were black text on a white screen with a dark grey terminal, closely followed by the context colours black, white, and light grey. It was also found that it is an advantage when the context colour is the same as the colour of either the colour of the text or the background on the screen. The combination of context and text/background colours must match against each other. If they clash the reading effort increases. Further experiments (op. cit.) with altering ambient light levels showed that this is of no or very limited importance for the perceived reading effort.

Numeric data on the screen

Computer graphics hardware and software have become widely available. In advertisements it is often stated that business graphics communicate the information effectively, thus being very useful. However, in real-life situations graphics often tend to be very poorly designed. Thus they may fail to improve the communication. Sometimes bad design might even make communication difficult or even impossible. Bertin (1967), Cossette (1982), McCleary (1983), and Pettersson (1983, 1989) all discussed the importance of individual design variables in visual

language. However, these discussions are all based on research on traditional print media. Ehlers (1984) points out problems of legibility in business graphics. According to him, direction and pattern and texture of graphic elements appear to be important factors as well as colour and size.

The CLEA-laboratory studies of attitudes to different variables in the presentation of information on visual displays (Pettersson et al., 1984b) showed that subjects consider it easy to see the difference between vertical bars as well as between horizontal bars.

Further experiments by Fahlander and Zwierzak (1985) have shown that the greater the difference is between the colour in a graphic presentation, the more distinct is our perception of the border between the colour spaces. On white background the following colour combinations are suitable to use: black combined with yellow, yellow-red, red, blue, green or the mixtures of red-blue (magenta), blue-green (cyan), and green-yellow. On black background the following colour combinations are suitable to use: white combined with yellow-red, red, blue, or the mixtures of red-blue. On white as well as on black background the following combinations are suitable to use: yellow combined with red and blue, red combined with blue-green or green-yellow, red-blue combined with green or green-yellow.

Following this study Azoulay and Janson (1985) found that some colours used in business graphics have much higher aesthetic values than others. Blue, red, and green are liked the most. In an effort to find some more detailed knowledge about our perception of business graphics, two comprehensive experiments were carried out with respect to relationships between variables and parts of a whole (Pettersson & Carlsson,

1985). The findings, based on more than 2,300 individual assessments, were conclusive in the following points:

- Graphical information is good in conveying a survey of a situation.
- When relationships between variables are presented, comparisons of lengths give the best results.
- When parts of a whole are presented, comparisons of areas can be used as well.
- Design of graphic elements is important to consider. Most available patterns are probably less good. Patterns should be subdued and not disturbing.
- Colours like blue, red, and green are liked very much but they do not improve our possibility of reading the message accurately.
- Different parts in graphic figures should have about the same luminance and radiance. The true differences between areas can be hard to see when shaded differently.
- When accuracy is needed, graphical information should be combined with actual figures.

"Choosing the Right Chart" ISSCO (1981) supplies 21 practical guidelines and pointers on effective chart design such as: "Make bars and columns wider than the space between them". In a study Ek and Frederiksen (1986) used the CLEA-equipment to find out about effective chart design. Forty subjects assessed the difference in size between two bars in a bar chart with six bars. The bars had one of three possible widths (1/60, 1/30, and 1/15 of the screen width). The distance between the bars had one of six possible values, from zero to more than twice the bar width. The bar charts were produced and displayed at random and al-

ways presented with blue bars on black background. The findings, based on 3,600 individual assessments, showed:

- The bar width has no influence on our perception of size.
- The space between bars has no influence on our perception of size.

This study confirmed earlier findings (with the perception of vertical lines). It can be concluded that we can make screen design according to aesthetic appeal. Finally, it may be stated that it is extremely easy to convey misleading information about statistical relationships by using misleading illustrations. Those who are serious in their work should seek to avoid these mistakes.

Visuals on the screen

Our perception of visuals on visual displays are of course to a large degree dependent on the quality of the screen, especially when pie charts are used. European videotex terminals simply cannot reproduce a pie chart since the graphics resolution is only about 5,000 graphical elements. An ordinary television image consists today of about 250,000 image points or picture elements which vary with respect both to grey scale and colour information. Hayashi (1983) reported on the development of High Definition Television (HDTV) in Japan. HDTV uses 1125 scanning lines and can contain five or six times more information than the present NTSC standard colour television system with 525 lines. HDTV developments of flat plasma screens will also give increased technical possibilities for better perception of the visual information.

Windows on computer displays

General design rules should be employed also in the design of screen displays with information that is intended to be read on the screen rather than printed out on paper. Thus, material should be arranged and displayed so that it is easy to read: from top to bottom and from the left to the right.

For good legibility text in windows on a computer display may be set in 14 point Helvetica or New Century Schoolbook with 16–18 point line spacing, and an additional six points of space after each paragraph. The line length may be up to 120 millimetres wide. A window heading may be set in 18 points bold Helvetica with 24 point line spacing and an additional six points of space after the paragraph. For text in illustrations, I recommend 10–12 point Helvetica. Blank space in printed material increases cost, since more paper is required. Thus, it is not often used. However, colour as well as blank space on a visual display are essentially free and might be used to increase legibility and readability.

The layout of an "ideal window for a computer screen" should be adapted to the need of showing both separate video pictures and video sequences. An ordinary television screen corresponds with a 60 to 90-millimetres-wide picture on a computer screen. Thus the window should be at least 90 millimetres wide. The layout of the window may be adapted to well-known picture sizes, such as: overhead transparencies in accordance with SIS, with the height-width ratio of 1:1,29, television (1:1,32), standard film (1:1,33), European A and G series for paper (1:1,41), Cinema U and IMAX (1:1,44), the effective picture area of a slide (1:1,53), the golden section (1:1,62), Vistavision Europe (1:1,85), Showscan (1:2,18), and Cinemascope (1:2,35).

The layout of an "ideal window for a computer screen" should be adapted for easy transfer of traditional, and page related electronic documents into an electronic document. Moving pictures between different formats and different media should be as easy as possible: documents on paper – documents on computer screens – overhead transparencies – slides – video. It is a good idea to only use a limited number of document templates with agreed standards for typography and layout. The agreed layout limits the size of pictures. The picture width is the most critical; it is often limited by the text column width. The picture height is limited by the column height, usually the height of the paper reduced with upper and lower margins. Sometimes, there are problems with the picture widths, but almost never with the picture heights. The window height should be adapted to the normal text height, and the height of the most common pictures including captions.

In search of an "ideal window for a computer screen" a summary of all these criteria, the lowest common denominator, results in an information window (143 x 190 millimetres) with a text and picture area, an "information area," (120 x 160 millimetres). This active text and picture area has the same side ratio as standard film (1:1,33), and almost the same as a television screen (1:1,32).

Each information material may be regarded as a reel of film in a feature film, with film-frames instead of pages in a book. Contrary to the situation with film, we can with the help of hypertext links move as we wish, from frame to frame in the complete information material. The window is designed from the side ratio 3:4 (1:1,32). This ratio is the basis for the size of the hypertext keys (8 x 6 millimetres), for the distance between the buttons (three millimetres), for the placement of the buttons

(six millimetres from the information area and three millimetres from the borders), and for the placement of the identification texts (six millimetres under the information area and three millimetres above the border). The space above the information area is totally nine millimetres. Below the information area, to the left, there are a number of buttons for hypertext-linked steps to each section (level) in the information material. To the right there are a number of hypertext tools: go to the first page, go one page back, go one page ahead, go to the previous page, go to the page with information on originators, go to list of pictures, go to page with copyright information, go to page with a list of illustrations, go to page with an index and hypertext links to the complete material, go to the page with help and explanations, and close the document.

Above the information area there is a field with administrative information, such as the company name, the title of the information material, the document number, and the current number of the "frame" or page. This information only has a limited value in the electronic document, where all the administrative information may be put together in the last frame. However, this information is important when printing one or more frames. On an A4 paper there is space enough to print one frame. The window may be used for one column (160 millimetres) and also for two columns (40 + 120 millimetres). The header levels number two and three may start to the very left of the window, that is, in the narrow column. Small pictures, symbols and notes may also be placed here. The full width of the window may be used for large pictures.

In one design experiment as much as 93% of all the pictures in a major system description project could be moved directly into such an electronic document. The texts in the pictures,

however, needed to be enlarged from nine to ten, or preferably to a twelve point linear typeface such as Helvetica. However, the information in an information material may well be divided so that the text is shown in one window and all the pictures in another, similar window on the computer screen.

The picture height will be decisive for the use of pictures. There will be some "empty" space both to the left and to the right of the picture. After appropriate enlargement, according to an enlargement table, both line width and texts usually need to be revised. If we want to work with text only in a window, and present all the pictures in a separate window next to the text window, we may use a narrower variation for the text. Such a "text window" may measure 143 x 150 millimetres, and have an "active" text area of 120 x 120 millimetres. This window will only contain a text column, with a column width of 120 millimetres.

In WWW the individual user is able to define the size of the display window at will. To a large degree the user can also decide on his or her own preferred typography. Although the typographic possibilities are limited in HTML-documents (compared with SGML-documents) it is still possible to provide a clear structure and make it possible to navigate within the document as well as between different documents. A consistent use of size and weight in headings is important. This should be combined with a consistent use of empty space to further enhance clarity.

Keeping a list of contents with links to chapters or sections in the current document (or group of documents) in the "list of contents area" makes it possible to maintain an understanding of the structure of the present document (or group of documents). In the "text and picture area" it is possible to succes-

sively view all the available information. A specific area for administrative information can be placed at the bottom of the text and picture area. This information will be printed when the document is printed.

Computer print-outs

In visual displays, an additive mixture of red, green, and blue produces the colour image. However, in the production of hard copies, computer printouts as well as in painting, printing and also colour photography a subtractive method of combining inks, dyes and pigments is used. Most colours can be generated in printing with the use of yellow, cyan (blue-green) and magenta (red-blue). Together these primaries produce black. However, pure black is often included as a fourth printing colour because the three primaries that produce the best chromatic colours usually do not produce the best black. Subtractive systems begin with a white surface. Colours darken as more wavelengths are absorbed. (However, in some colour hard copy printing, both additive and subtractive colour combinations can occur.)

The difference in the production of colours creates some problems. It should also be remembered that colour coding will lose its meaning when monochrome printers, as well as displays, are used. There are many hard copy systems and possibilities to make computer printouts for text as well as for pictures.

In a study (Pettersson et. al., 1984c) printouts from line, matrix, and daisy wheel printers were used. These eight samples were numbered and showed at random to 40 subjects who judged their perceived reading efforts of the different texts. The results showed that:

- Only the two daisy wheel printouts and a normal font, normal mode matrix printout cause little reading effort and thus are easy to read and quite acceptable.
- Reading efforts of print-outs are independent of the sex of the subjects

It was concluded from this study and the previous findings (Pettersson et. al., 1984a) that a text presented in a good colour combination on a visual display was easier to read than printouts from several printers used. Today, however good quality laser printers are often used.

Layout

A finished layout is the practical result of the work in the graphic design process. The purpose of this work is to find a suitable presentation for the content with respect to the receiver, the subject matter, the medium, and the overall financial situation. Within a given area – such as a page in a book, a poster, or a label – the graphic designer may arrange and distribute text, pictures (drawings and photographs), and the background (margins, space, patterns, and designs without any significant picture elements). Layout provides a large number of possibilities to make the structure in a document clear (Benson, 1985; Tinker, 1963, 1965). The graphical form should help the reader to benefit from the contents of a document.

Paper size

Traditionally, a large number of different paper sizes were defined for large sheets of paper. Local paper sizes were defined by the name of the sheet and by the number of times it had been folded. Different paper sizes were used for different purposes. The aspect ratio varies a lot in many standards for paper sizes.

Today there is one widespread international ISO standard and a local standard used in North America. Paper sizes affect cards, envelopes, printed documents, stationary, and writing paper.

All *ISO paper sizes* are based on a single aspect ratio of the square root of two, approximately 1:1.4142. The base for the system is the A0 paper. An A0 (A zero) paper has an area of 1 m^2, with the sides 841 and 1189 millimetres (33.1 in × 46.8 in). The *A-series* can be traced back to a French law from 1798 for certificate papers.

Successive *A series* paper sizes are defined by halving the preceding paper size along the larger dimension. The system with scaling is a significant advantage. The most frequently used paper size is A4 210 by 297 millimetres (8.3 in × 11.7 in). A standard A4 sheet made from standard 80 grams per m^2 paper weighs 5 grams.

Size A0 is 841 × 1189 mm, A1 594 x 841, A2 420 × 594, A3 97 × 420, A4 210 × 297, A5 148 × 210, A6 105 × 148, A7 74 × 105, A8 52 × 74, A9 37 × 52, and A10 26 × 37 mm. The number after A accounts for the number of folds.

The *B series* is less common than the A series. The area of a B series sheet is the geometric mean of successive A sheets. The B-series is widely used in the printing industry. Many posters use B-series paper or a close approximation, such as 50 cm × 70 cm.

Size B0 (B zero) is 1000 × 1414 mm, B1 707 × 1000, B2 500 × 707, B3 353 × 500, B4 250 × 353, B5 176 × 250, B6 125 × 176, B7 88 × 125, B8 62 × 88, B9 44 × 62, B10 31 × 44 mm.

The *C series* is used only for envelopes. The area of a C series sheet is the geometric mean of the areas of the A and B series sheets with the same numbers. A letter that is written on A4 paper fits inside an envelope in size C4.

Size C= (C zero) is 917 × 1297 mm, C1 648 × 917, C2 458 × 648, C3 324 × 458, C4 229 × 324, C5 162 × 229, C6 114 × 162, C7 81 × 114, C8 57 × 81, C9 40 × 57, and C10 28 × 40 mm.

In Sweden the ISO system of A, B, and C formats is supplemented by adding D, E, F, and G formats. G5 (169 × 239 mm) and E5 (155 × 220 mm) are popular for printing dissertations.

The most commonly used paper sizes in North America are called *Ledger, Legal, Letter*, and *Tabloid*. A ledger size paper is

432 x 279 mm (17 x 11 in). A legal size paper is 215.9 x 355.6 mm (8.5 x 14 in). A letter size paper is 215.9 × 279.4 mm (8½ × 11 in). Letter size is also known as American Quarto. A tabloid size paper is 279 x 432 mm (11 x 17 in). Note that a ledger size paper and a tabloid size paper have the same size, but ledger is vertically oriented and tabloid is horizontally oriented.

Arch is a series of paper sizes used in architecture. In this series the aspect ratios vary, 4:3 and 3:2 are common. Five successive paper sizes are defined by halving the preceding paper size along the larger dimension. Here the aspect ratio varies between 3:4 and 2:3.

Arch A is 9 x 12 in (229 x 305 mm), Arch B 12 x 18 in (305 x 457 mm), Arch C 18 x 24 in (457 x 610 mm), Arch D 24 x 36 in (610 x 914 mm), Arch E 36 x 48 in (914 x 1219 mm), Arch E1 30 x 42 in (762 x 1067 mm), Arch E2 26 x 38 in (660 x 965 mm), and Arch E3 27 x 39 in (686 x 991 mm).

Page composition

An “empty” page can be considered as an available area or space. This area may be and should often be used in different ways. In all printed matter, space can be used to convey the structure of the information. The information can be grouped in various ways. There may be plenty of white space on a printed page. Headings, margins and “empty” space can be used to aid communication when used in a consistent way (Hartley & Burnhill, 1977a, 1977b).

Learners are most able to build connections between verbal and visual representations when text and illustrations are actively held in memory at the same time. This can happen when text and illustrations are presented in close connection on the same page in a book, or when learners have sufficient experi-

ence to generate their own mental images as they read the text (Mayer et al., 1995).

According to Baggerman (2000, p. 64) most designers don't consider print design in terms of its interface. However, since desktop publishing has revolutionised the options for page layout, the professional designer must use the interface of print design in order to connect directly with the user.

Page size

In traditional as well as in desktop publishing the available paper defines the possible page sizes. The use of standard page sizes can aid communication. Hartley and Burnhill (1977b) are strong advocates of international standard paper sizes. Their own experimental materials are printed on A4 paper. We may choose from different kinds of page formats. A quadratic format is static. It is often considered uninteresting and it is seldom used. Wide formats correspond with our vision. In printed materials wide formats may be used to present pictures in large sizes. Tall formats are very suitable for presentation of printed text and are the most common format for books. Classical formats are based on the proportions of the golden section, 3:5, 5:8, 8:13, 13:21, 21:34, etc. Each new number in the scale is the sum of the previous two numbers. Many experiments have shown that there is an optical centre on a page.

In our daily life we often use A4 paper – with a width-to-length ratio of 1:1.41 – for copied/printed matter. The text area (the portion of the page that will contain text and pictures) should be large enough, in order for the information to fit in. To satisfy a requirement for single-sided printouts that can be inserted into a loose-leaf binder, while at the same time being able to make double-sided printouts that can be bound in book form,

right-hand and left-hand pages should be identical. In a traditionally printed book, however, we can use different inner and outer margins, and adapt the page layout for even more convenient reading.

If one wants to fill the whole width of the page with text, the text must be written in a large type, with ample distance between each line. It is preferable to have narrower lines than that. If pictures are used, it might be suitable to allow them to fill the entire text area from margin to margin. Necessary administrative information, the chapter title, and the page number may be provided in the lower or upper margins.

In documents with only text, or with text and very few pictures, two columns of text may function very well on an A4 page. In such a layout, a column width of 80 millimetres with 12 points text is quite satisfactory. However, in documents that have plenty of pictures, two or more columns will pose some difficulties and demand a good deal of extra work. As long as a document is subject to recurring amendment, supplementation and other updating measures, a layout with only one column is preferable.

Text face

The appearance of a book page is governed by the fact that Western readers begin at the top left of a page and read to the right, one line of text at a time until they get to the bottom of the text column. Often the main part of the page is the text-face. Depending on the page size the page may be used for one or more columns of text and pictures. Hartley and Burnhill (1977a, 1977b) have done extensive research on psychological research on typography based on basic principles of typographic deci-

sion-making. They worked with the following three main principles:

1. Use typographic space in a consistent way in order to convey the structure of the information.
2. Use standard page sizes.
3. Use grids for pre-planning of pages.

By grouping headings, paragraphs, illustrations, and captions the designer aids communication. An “empty” line might separate paragraphs, two lines subsections, and three or four lines sections. In this process the principles from the Gestalt theory can be utilized. When we use space to group graphic components, we employ the “proximity principle” or the “proximity law”. When we use a consistent type to signal a particular kind of graphic component, we employ the “similarity principle”. When we use grid systems these are based on the “closure principle,” together with the “continuity principle.”

The classic model for page design

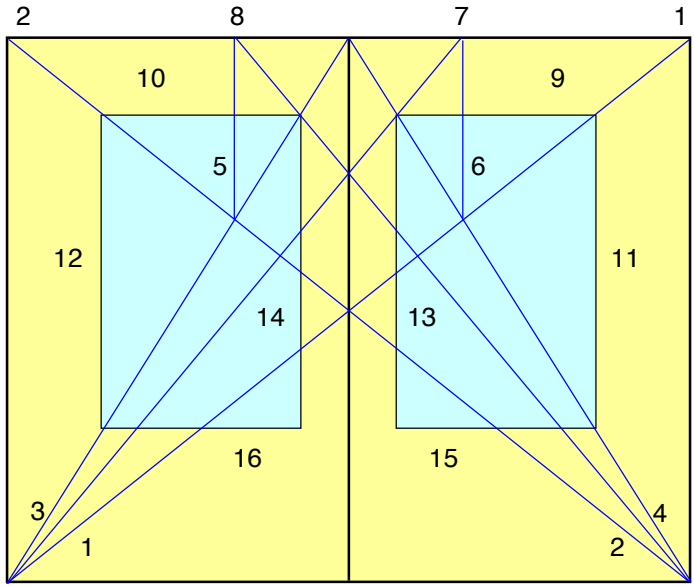
White or “empty” space on a page can contribute to the creation of a harmonious and functional product. An old method of deciding the appropriate sizes for margins on a two-page spread is based on geometry:

1. Draw a diagonal from the lower left corner of the left-hand page to the upper right corner of the right-hand page.
1. Draw a diagonal from the lower right corner of the right-hand page to the upper left corner of the left-hand page.
2. Draw a diagonal from the lower left corner on the left-hand page to the upper right corner on the same page.

3. Draw a diagonal from the lower right corner on the right-hand page to the upper left corner on the same page.
4. Draw a perpendicular to the top of the page from the point where the two diagonals cross on the left page.
5. Draw a perpendicular to the top of the page from the point where the two diagonals cross on the right page.
6. Draw a line from the point where the perpendicular meets the top of the right page, down to the lower left corner of the left page.
7. Draw a line from the point where the perpendicular meets the top of the left page, down to the lower right corner of the right page.
8. Draw a line to the right, parallel to the page edge, from the point where diagonal 4 and line 7 cross, to diagonal 1. This line will establish the top margin on the right page.
9. Draw a line to the left, parallel to the page edge, from the point where diagonal 3 and line 8 cross to diagonal 2. This line will establish the top margin on the left page.
10. Draw a line, parallel to the page, from the point where diagonal 1 and line 9 cross, down to diagonal 4. This line will establish the right margin on the right page.
11. Draw a line, parallel to the page, from the point where diagonal 2 and line 10 cross, down to diagonal 3. This line will establish the left margin on the left page.
12. Draw a line, parallel to the page gutter, from the point where line 7, line 9 and diagonal 4 cross. This line will establish the left margin on the right page.
13. Draw a line, parallel to the page gutter, from the point where line 8, line 10 and diagonal 3 cross. This line will establish the right margin on the left page.

14. Draw a horizontal line from the point where diagonal 4 cross line 11 to the left. This line will establish the bottom margin on the right page.
15. Draw a horizontal line from the point where diagonal 3 cross line 12 to the right. This line will establish the bottom margin on the left page.

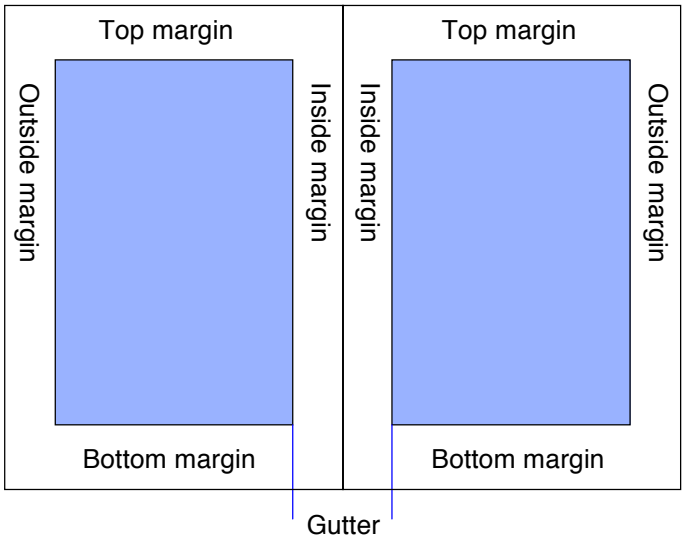
As can be seen in the illustration on the next page this method creates large margins, with the text covering only one-third of the page. West (1987) called this model “ideal” and “classic”.



This is an illustration of the construction of the classic model for page design.

Margins

Margins have three main functions. They provide space for comments, headings, illustrations, page numbers and personal notes. They provide space for fingers to hold a document while reading it. They make it possible to make notes.



The classic model for page design creates very large margins.

Surrounding of white space

The text-face is surrounded by margins. There are four margins; a header (or top margin) and footer (or bottom margin), an inner, and an outer or outside margin. Taylor (1960, p. 112) noted, "a surrounding of white space will bring attention to any object being surrounded". According to Waller (1987), the observations on which the Gestalt theory is based form a basic part of the graphic designer's craft knowledge. These principles might be seen as relatively inflexible perceptual rules that act as a fundamental constraint for the typographer alongside such con-

ventional rules as the left-to-right direction of the writing system.

Footers may appear at the bottom of every page. They should provide information that will help the reader navigate in a document. Footers often carry page numbers. There may also be footnotes.

Headers, or *running heads*, may appear at the top of every page. They should provide information that will help the reader navigate in a document. In some books every left-hand page have the title of the book, and every right-hand page have the name of the chapter. Headers may also carry page numbers.

Size of margins

A general guideline may be to make all margins one inch on a standard page (Bradshaw and Johari, 2000). However, there are a number of exceptions to this guideline and margins. Usually margins differ in size.

According to Hartley (1985, 1994), Lichty (1989, 1994) and Misanchuk (1992) readers expect margins to occupy 40–50% of a standard 8 1/2" x 11" page, although this amount can be reduced in professional or scholarly texts. Some guidelines call for even larger margins (Burns, Venit, and Hansen, 1988).

Guidelines for margins vary a lot (Ander, 2003; Bergström, 1998; Berndal & Frigyes, 1990; Bohman & Hallberg, 1985; Hellmark, 2000a, 2000b; Koblanck, 1999; Lohr, 2003; Misanchuk, 1992; Pettersson et al., 2004; White, 1983). Recommendations for top margins are often between 14 – 35 millimetres, for right margins 6 – 53 millimetres, for the bottom margins 14 – 34 millimetres and for the left margins 8 – 28 millimetres.

With very thick books, the part of the page that is bound will have a section that we cannot see. Thus, thick books need to

have wide inner margins. This part of the page is called the gutter. On a two-page spread the right side of the left page is the gutter, and the left side of the right side is the gutter.

Page numbers

In all kinds of reference materials, it is important to have page numbers, folios. The reader can find information in the material by using the table of contents and/or the index. Page numbers should be clear and easy to find. There are many possibilities for placement of the page numbers.

Page numbers can be put to the left, in the middle, or to the right in the header or in the footer. Page numbers are sometimes also put in the margin. In products with large page sizes, it is usual to put page numbers in the header. In products with small page sizes, it is quite common to put page numbers in the footer. Usually readers are likely to look for page numbers in the margin at the bottom of the page (Lipton, 2007, p. 134). However, this should not to be considered a rule. The important thing is consistency.

Page numbers indicate arbitrary divisions of the text. For technical reasons many books contain more than one series of page numbers. For example, technical manuals and instructional materials often use a separate numbering series for each chapter. Then a single chapter can be updated without reprinting the whole manual. The running head includes the name of the publication, the issue date, or other header or footer style material.

Grid systems

Look at different books, reports, magazines, and papers and study the variety of page sizes and page designs. In many books

the page has only one column, which is very good for undisturbed and easy reading. However, a wide page has to be divided. Too wide lines impair reading. Book pages with two columns are quite common. Even three columns can be used, e.g., in dictionaries and reference books. Pages with four or more columns are very rare. One-column layouts are the most used layouts in instructional materials. It is easy to work with, especially when materials may have to be revised frequently. Davies, Barry, and Wiesenberg (1986) suggest that one, two, or three columns per 8 1/2" x 11" page are reasonable for reports, papers, and other similar documents.

In magazines it is common that different sections have their individual page designs. One section may have three columns, another section four columns, and a third section five columns. Pages with six or more columns are very rare. In newspapers it is common that a page has six, seven, or eight columns. Newspaper pages with four or five as well as with nine or ten columns may also be used. Pages with eleven or more columns are very rare. It is very easy to create complicated typography and page layout. However, simplicity and consistency are very important. Complexity usually interferes with communication. Readers should not be forced to search on the page for headings and page numbers. Typographic grids may be used to ensure that space and print are used consistently. It is important that the printed page provide a reliable frame of reference from which the learner can return without confusion. By dividing a page into smaller sections, a specific topic may be presented in a variety of combinations of grid sections. A grid establishes a structure to build upon. There are different kinds of grid systems. We can distinguish between one-column grids, multicolumn grids, modular grids, and irregular grids. Many books

and other documents use a standard page with a fixed text-face, a live area. Type and other graphic elements occupy the text-face. The grid establishes the location of the text-face, the inner and outer margins, the header, and the footer on each page.

Traditionally graphic designers work with grid sheets printed in light blue ink. The “non-repro” blue ink will not show up on films, printing plates, or on the final print. The grid is used to ensure that type and graphic elements are pasted on correct locations. In electronic page layout systems the software can create electronic grids. They are called master pages. A master page is shown on the screen but does not print. In columnar grids the text flows from one column to another. Dictionaries and telephone directories are examples of simple columnar grids. In parallel columnar grids the text flows in columns that are related horizontally. This system is sometimes found in multilingual manuals with the same text in different languages.

The modular grid is the classical Swiss grid. It is based on regular rows as well as columns. Often a modular grid system is used for “blocked grids”. For example, it is possible to use columns with different widths to present texts and illustrations. Usually “topic frames” are rectangular. The purpose is to create clear visual gestalts. Many tabloid newspapers use irregular grids. The topic frames are often not rectangular. Editorial stories are mixed with advertising items. The purpose of irregular grids is actually to prevent clear visual gestalts. The reader can never get an understanding of the page at only one glance.

Effective grid-based design requires both careful planning and a willingness to adjust to the content itself when this is needed. Fitting the content to the grid should be seen as a way of regularizing the information and increasing its internal consistency in order to improve communication.

Oppositions

By tradition page layout is based on symmetrical page design. Centred as well as justified texts are examples of symmetrical layout. Symmetry is axial balance. It is logical and simple to design. Symmetrical page design is static and may be perceived as boring. An asymmetrical layout can be based on contrasts of size, strength, shape, area, or colour. Unjustified text flushed left or right are examples of asymmetrical layout.

Symmetrical as well as asymmetrical layouts can have a good balance. The favouring of uniformity in the use of design elements is *regularity*. The opposite, called *irregularity*, emphasizes the unusual and unexpected. A layout may be built on simplicity using few and simple elements and simple forms.

The opposite strategy is based on complexity. Dondis (1973) discussed the use of several pairs of oppositions as techniques for visual communication. These oppositions are:

Balance	–	Instability
Symmetry	–	Asymmetry
Regularity	–	Irregularity
Simplicity	–	Complexity
Unity	–	Fragmentation
Economy	–	Intricacy
Understatement	–	Exaggeration
Predictability	–	Spontaneity
Activeness	–	Stasis
Subtlety	–	Boldness
Neutrality	–	Accent
Transparency	–	Opacity
Consistency	–	Variation
Accuracy	–	Distortion

Flatness	–	Depth
Singularity	–	Juxtaposition
Sequential	–	Random
Sharpness	–	Diffusion
Repetition	–	Episodic

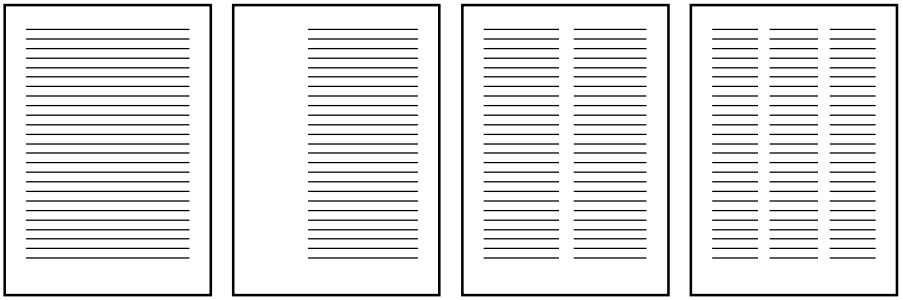
These different visual design techniques overlap and reinforce meaning. They present the graphic designer with effective means of making expressive visual communication.

Text layout

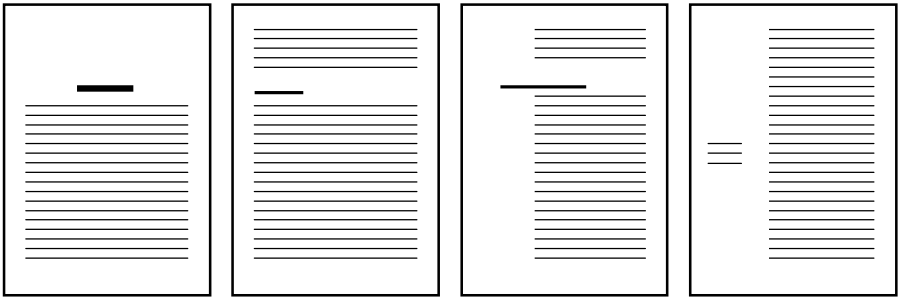
Lupton and Miller (1999, p. 33) started their chapter about *Period Styles* in this classical way:

GREEKANDLATINMANUSCRIPTSWEREUSUALLYWRITTEN
WITHNOSPACEBETEENWORDSUNTILAROUNDTHENINT
HCENTURYADALTHOUGH.ROMAN.INSCRIPTIONS.LIKET
HE.FAMOUS.TRAJANCOLUMN.SOMETIMES.SEPARATED.
WORDS.WITH.ACENTERED.DOT. ...

Today graphic designers use typographic variation to present the content in a text in a clear way. Reference materials, such as telephone books and dictionaries are examples of highly structured information. Here, a carefully thought-out, functional layout can facilitate the reader's ability to find the desired information quickly, easily, effectively, and reliably.



There are vast possibilities of text design. The whole page may be used for one column of text. The left or the right margin may be wide to leave space for notes. The text-face may also be divided into two or more columns.



The text may start down the page in each new chapter. Sub-headings are often located within the text column, but they may poke out in the margin. There may also be printed notes in the margin.

Text must have a typography that facilitates its legibility. Headings, sub-headings, main text, captions, boxes, summaries, etc., must be clearly distinguished from one another. For reports, and similar documents, it is reasonable to use one, two, or three columns on the page (Hartley & Burnhill, 1977a, 1977b). Consistent use of columns will help to establish a regular pattern throughout a project (Lipton, 2007, p.120).

In typography a “widow” is the first line of a paragraph alone at the bottom of a column. Sometimes a widow refers to the last line of any paragraph with only a few words. The first line of a paragraph should not, as a rule, begin on the last line of a text column. Similarly, the last words in a paragraph should not be placed alone at the top of a new page or a new column. Many word processing programs automatically eliminate awkward phenomena like these. An “orphan” is the last line of a paragraph when it is alone at the top of a column.

In some documents lines need to have numbers. Non-arbitrary numbering systems include the numbering of lines where line endings are meaningful. This might be the case in computer programs, in dictionaries, and in texts used for linguistic analysis. Non-arbitrary numbering systems also include the numbering of paragraphs and the numbering of headed sections.

Justified or unjustified text?

A text may be justified or unjustified. An unjustified text can be flushed left, centre justified, or flushed right. There are some advantages and some disadvantages with each system. The following pages include four examples of the same text fragment in the four different versions: justified text, centre justified text, flushed left text, and flushed right text.

Justified text

A number of authors argue that *justified text* (sometimes called right-justified text or full text) is aesthetically pleasing and that it is easier for people to read lines of the same length than reading lines with markedly varying right-hand ends (Lang, 1987;

Lichty, 1994). Justified text is commonly used for running text in books, magazines, and newspapers.

To achieve a justified text the technical system inserts extra space between words and between characters. According to Kleper (1987). The practice of having text justified is a tradition in the publishing industry that originated with the scribes who copied text by hand before the invention of movable type. At that time paper was expensive and the scribes attempted to put as much text as possible onto every page, filling each line completely.

The blue text fragment below is justified
Infology is the science of verbal and visual presentation and interpretation of messages. On the basis of man's prerequisites, infology encompasses studies of the way a combined verbal and visual representation should be designed and produced in order to achieve optimum communication between a sender and a group of receivers. Infology models contain both theoretical (descriptive) elements as well as normative (prescriptive) elements.

Burns, Venit, and Hansen (1988) pointed out that the use of metal type required that the right edges of type align in the page form so that the type could be locked into place. Until recently most publishers had regarded anything other than justified text as unprofessional. Lang (1987) argued that justified text is aesthetic, it serves to define the right margin, and it is familiar to the readers. Also Lichty (1989) argued that it is easier to read lines of the same length than lines with markedly varying right-hand ends. According to Machin (2007) justified text may be seen as authoritative, efficient and formal.

Hartley (1985) and Hartley and Burnhill (1977a) argued that justified text is not a good idea for instructional materials. The variable spacing between words as well as the use of hyphenation makes reading less smooth and more difficult.

When justified text is set in too short lines, there will be "rivers of space" between words, or characters spaced out to fill the lines. Justification should be avoided with narrow columns in multi-columnar layouts (Davies, Barry, and Wiesenberg, 1986). Misanchuk (1992) claims that there are no good arguments at all for using justified text.

Centre justified text

Symmetrical centre justified texts may be seen as formal, grave and momentous ((Machin, 2007). However, without symmetry centre justified texts may be seen as energetic, informal and playful. Symmetrical centre justified texts are often used for menus, quite often used for poetry, and sometimes used for short captions and tables of contents. In films and in television programs the participants are usually listed centre justified.

This blue text fragment below is centre justified

Infology is the science of verbal and visual presentation and interpretation of messages. On the basis of man's prerequisites, infology encompasses studies of the way a combined verbal and visual representation should be designed and produced in order to achieve optimum communication between a sender and a group of receivers. Infology models contain both theoretical (descriptive) elements as well as normative (prescriptive) elements.

Flushed left text

Today flushed left text, or *unjustified text*; with a "ragged–right–hand" edge is commonly used for running text in books, magazines, and some newspapers. A century ago flushed left text was restricted to poetry. At that time it was considered very odd and peculiar and most publishers regarded the use of anything other than justified text as unprofessional. According to Machin (2007) flushed left text may be seen as less formal and more relaxed than justified text.

Some authors argue that flushed left text is a much better choice than justified text (Hartley, 1994; Misanchuk, 1992). The exact spacing between letters and between all the words in unjustified text retains the optimal spacing between letters and between words and so keeps the visual rhythm constant. This aids reading, especially for young, inexperienced and poor readers (Gregory and Poulton, 1970; Zachrisson, 1965).

This blue text fragment below is flushed left

Infology is the science of verbal and visual presentation and interpretation of messages. On the basis of man's prerequisites, infology encompasses studies of the way a combined verbal and visual representation should be designed and produced in order to achieve optimum communication between a sender and a group of receivers. Infology models contain both theoretical (descriptive) elements as well as normative (prescriptive) elements.

Trollip and Sales (1986) experimented with justified and flushed left text. Results indicated significant increase in reading time for groups reading justified text. No differences in comprehension were detected. Poor readers have difficulty

reading justified text (Gregory and Poulton, 1970; Zachrisson, 1965). However, whether the text is justified or unjustified causes no significant difference in search time and comprehension of the information for advanced readers (Hartley, 1987).

However, many readers find justified text much more aesthetically pleasing than flushed left text. They may even feel that the ragged right is ugly and repulsive.

Flushed right texts

Flushed right texts can be used for captions that are positioned to the left of the pictures, and for tables of contents. This is, however, only possible when the line length is short. Since flushed right texts demands more effort to read they suggest more confidence than justified texts (Machin, 2007).

This blue text fragment below is flushed right

Infology is the science of verbal and visual presentation and interpretation of messages. On the basis of man's prerequisites, infology encompasses studies of the way a combined verbal and visual representation should be designed and produced in order to achieve optimum communication between a sender and a group of receivers. Infology models contain both theoretical (descriptive) elements as well as normative (prescriptive) elements.

Regardless of justification system the ends of sentences should be determined by syntax rather than by an idea of a set width of the line (Hartley, 1980; Bork, 1982).

Line length

It is easy to change the *length of lines*. According to Tinker (1963), readers tend to dislike both very short and very long line

lengths. Tinker made extensive studies of typography. He worked with characters in sizes of nine to twelve Pica points and recommended ten to twelve words per line. This results in a line length of eight to ten centimetres. There are, however, several other recommendations of line length.

West (1987) suggested that the line length should be 35–40 characters. Quite often the optimum line length seems to be about 1 1/2 alphabets – 42 characters (Pettersson, 1989; Walker, 1990). This is nine to eleven centimetres with optimum character size, ten to twelve points, at a normal reading distance. Lipton (2007) suggested 40–50 characters and Parker (1988) 50 characters. Burns, Venit, and Hansen (1988), and Zwaga, Boersma and Hoonhout (1999) suggested up to 60 characters. Miles (1987) suggested 60–65 characters. A text column may be widened up to 120–130 millimetres to accommodate more text, and still be easy to read for an experienced reader. It is quite clear that too wide lines impair reading.

In my opinion the maximum line length should not be much more than 60–70 characters. This is except for books intended for highly skilled readers. The optimum line length should be found for each individual purpose and each audience. However, costs often force people to use more characters on each line, so that the total number of pages can be reduced. The longer the lines the wider the vertical space between them needs to be (Waller, 1987).

The length of a line will affect reading speed (Duchnicky and Kolers, 1983). Different kinds of publications should use different line lengths. The optimum line length should be found for each individual purpose and audience. The width of a line of type is traditionally measured in picas or Cicero. A pica, as well as a Cicero, equals 12 points. As systems for desktop publishing

become more common, line lengths will be measured in inches or centimetres instead of picas or Cicero's.

The line length may vary considerably. The longer the line is, the larger the type size should be. The shorter the line is, the smaller the type size can be. If justified text is set in lines too short, you get rivers of space between words, or characters spaced out to fill. Following on the next pages are examples of different line lengths with the same type size; too short lines, short lines, optimum line length, and long lines. All examples are given with unjustified as well as with justified lines. All examples use the same rules for hyphenation. In all examples the shortest prefix as well as the shortest suffix is set to three characters in UK English.

However, Zwaga, Boersma and Hoonhout (1999, p. xxii) argued that there is no such thing as the "best" column width or line length. The typographic features of printed matter should be chosen in relation to the requirements of the material to be printed. Line length can be relevant in the context of material consisting of sentences grouped in paragraphs, but as less important when there are also components such as tables, lists, diagrams and mathematical formulae. In these cases the constraints of a narrow column might be a disadvantage.

Too short lines 1

Producers of in-
formation and
learning materials
can facilitate
communication,
and the learning
processes of the
readers. Compli-
cated language, in
both texts and

Too short lines 2

Producers of in-
formation and
learning materials
can facilitate
communication,
and the learning
processes of the
readers. Compli-
cated language, in
both texts and

Short lines 1

Producers of information
and learning materials
can facilitate communica-
tion, and the learning
processes of the readers.
Complicated language, in
both texts and pictures,

Short lines 2

Producers of information
and learning materials
can facilitate communica-
tion, and the learning
processes of the readers.
Complicated language, in
both texts and pictures,

Optimum line length 1
Producers of information and learning materials can facilitate communication, and the learning processes of the readers. Complicated language, in both texts and pictures, will impair the understanding of the message. Active voice, clarity, comprehensibility, consistency, legibility, precision, readability, reading value, simplicity, and structure are the key concepts in information design. Any graphical message should be legible, readable, and well worth reading for the intended audience.

Optimum line length 1
Producers of information and learning materials can facilitate communication, and the learning processes of the readers. Complicated language, in both texts and pictures, will impair the understanding of the message. Active voice, clarity, comprehensibility, consistency, legibility, precision, readability, reading value, simplicity, and structure are the key concepts in information design. Any graphical message should be legible, readable, and well worth reading for the intended audience.

Long line length 1

Producers of information and learning materials can facilitate communication, and the learning processes of the readers. Complicated language, in both texts and pictures, will impair the understanding of the message. Active voice, clarity, comprehensibility, consistency, legibility, precision, readability, reading value, simplicity, and structure are the key concepts in information design. Any graphical message should be legible, readable, and well worth reading for the intended audience.

Long line length 2

Producers of information and learning materials can facilitate communication, and the learning processes of the readers. Complicated language, in both texts and pictures, will impair the understanding of the message. Active voice, clarity, comprehensibility, consistency, legibility, precision, readability, reading value, simplicity, and structure are the key concepts in information design. Any graphical message should be legible, readable, and well worth reading for the intended audience.

As we can see from these examples, short lines cannot handle justified setting very well. The distance between the words is too long. We get white "rivers" of space in the text column. A line of 40 to 50 characters or "strokes" results in a line length of 75 to 90 millimetres in a book or a paper. A text column may be widened up to 120 millimetres to accommodate more text, and still be easy to read for an experienced reader. This column is 120 millimetres.

Interline distance

The "interline distance," "interline spacing," "line space," or "vertical spacing" is the vertical distance between the baselines in a text. In Times an 11-point text may be set on a 13-point line. This is written as 11/13, and read as "eleven on thirteen." The term "leading" refer to the extra space between the lines, the

”line–to–line” spacing. In this case the interline distance is 13 points, and thus the leading is two points. The leading may vary considerably between different kinds of texts. In this column the text is set with Georgia 10/16. Georgia needs more space than Times.

The term *leading* is derived from the days of hot metal type when thin strips of lead were placed between lines of type to provide line spacing. However, today the word *leading* is sometimes used to measure the vertical distance between the baselines in a text.

Extra space is important for legibility. As previously noted the longer the lines, the larger the vertical distance should be. The reader needs to be able to find the next line without any trouble. In general, the opinion is that as the line length is increased, the need for more leading and larger type increases (Lipton, 2007; Misanchuk, 1992; Pettersson, 1989). Here the x-height is important. Typefaces with small x-heights manage well with less leading than typefaces with large x-heights.

For maximum legibility of the running text in a book a leading should be between one to three points when text size and line length are optimal (Benson, 1985; Hartley, 1987; Kleper, 1987; Lichty, 1989; Lipton, 2007, p. 124; Pettersson, 1989, Tinker, 1963). Texts on wall charts and overhead transparencies need more space between the lines. Children and inexperienced readers need more leading than experienced readers. Typefaces with small x- heights manage well with less leading than typefaces with large x-heights.

Here are six examples of a text fragment with ten short lines. Georgia 12/10 is compared with 12/12. Georgia 12/14 is compared with 12/16, and 12/18 is compared with 12/20. For

better and easier comparisons the left example in each pair is flushed right and the second example is flushed left.

Georgia 12/10

Infology is the science of verbal and visual presentation and interpretation of messages. On the basis of man's prerequisites, infology encompasses studies of the way a combined verbal and visual representation should be designed and produced in order to achieve optimum

Georgia 12/12

Infology is the science of verbal and visual presentation and interpretation of messages. On the basis of man's prerequisites, infology encompasses studies of the way a combined verbal and visual representation should be designed and produced in order to achieve optimum

Georgia 12/14

Infology is the science of verbal and visual presentation and interpretation of messages. On the basis of man's prerequisites, infology encompasses studies of the way a combined verbal and visual representation should be designed and produced in order to achieve optimum

Georgia 12/16

Infology is the science of verbal and visual presentation and interpretation of messages. On the basis of man's prerequisites, infology encompasses studies of the way a combined verbal and visual representation should be designed and produced in order to achieve optimum

Georgia 12/18

Infology is the science of verbal and visual presentation and interpretation of messages. On the basis of man's prerequisites, infology encompasses studies of the way a combined verbal and visual representation should be designed and produced in order to achieve optimum

Georgia 12/20

Infology is the science of verbal and visual presentation and interpretation of messages. On the basis of man's prerequisites, infology encompasses studies of the way a combined verbal and visual representation should be designed and produced in order to achieve optimum

It is obvious that there should be a little extra space between the lines in order to facilitate reading. Thus, a line with 12 point type needs an interline distance of at least 2 points (Times) or 3–4 points (Georgia). Generally speaking, one can use the type size plus 15–30% to determine this ratio.

Space

Space is an important tool in typography (Hartley, 1985, p. 27): "It is space that separates letters from each other. It is space (with punctuation) that separates phrases, clauses and paragraphs from each other; and it is space (with headings and sub headings) that separates subsections and chapters from one another." Consistent spacing in a document will help the readers to:

- Increase the rate of reading because they are more able to see redundancies.
- Access the more personally relevant pieces of information.
- See the structure of the document.

Space between words

Space between words varies in each line depending on the actual words and the actual line length. First the computer system adds word spacing and then, if the space between words becomes too excessive, the system will add letter spacing.

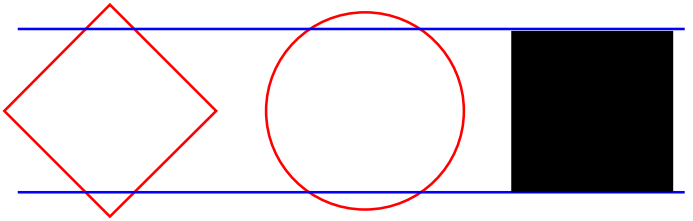
The distance between words shall be smaller than the distance between lines, and larger than the distance between characters. According to Walker and Reynolds (2004) a word space that is too wide or too narrow can ruin the design of a font. Space between elements should be used as a legibility tool (Lipton, 2007, p. 122). Text with a generous amount of space within it is rated as "easier" and "more interesting" than text that has a

more solid appearance. For comfortable reading it must be easy to distinguish between words. The distance between words should be relatively small. When the text has optimal spacing we can keep the reading rhythm constant.

Wendt (1979) inserted additional space between the constituents of the sentences to better convey the phrase structure of the text but found no difference in learning efficiency when compared with traditional text in one or in two columns.

Space between letters

The amount of space between letters in a text varies in each line depending on the actual words and the actual line length. Space between letters in text should not be too loose, or too tight. Visual design should be based on perceptual, rather than on physical phenomena. Compensation for shortcomings of our human vision is often required. Acute and rounded shapes need to be enlarged and extended in order to appear to be of equal height compared with a square. Visual alignment depends on careful optical adjustment to compensate for differences in shape of the element being aligned.



Acute and round shapes appear to be too low compared with a rectangle or a square.

Walker and Reynolds (2004) showed school children four texts with varying letter spacing and four texts with varying

word spacing. Results showed that more children noticed differences in letter spacing than differences in word spacing.

The distance between characters is sometimes too long. This is especially true for headlines in capitals. In traditional hand typesetting people used thin strips of metal, from 0.5 point upwards, for "correct" spacing of type.

In computer systems "empty space" is added automatically between the words and between individual letters when the text is set with justified lines. In photo typesetting it is possible to automatically and systematically increase the distance between characters in order to expand the text. It is also possible to reduce the distance between characters in order to condense the text. This is also possible in some systems for desktop publishing.

Kerning

In photo typesetting, and in some systems for desktop publishing, *kerning* is used to individually correct the distance between characters to achieve a better type. For example, when a capital A and a capital V are set without kerning, there is too much space between the letters. The A and V have slanted shapes, and the space between these letters is exaggerated.

With kerning, selected pairs of letters can be pushed together and overlap to create a better optical visual spacing between the letters. In optical spacing we need to equalize the area rather than the distance between characters. In typography, the tightest letter spacing is reserved for adjacent characters with curved edges or horizontally projected strokes. The widest spacing is allotted to character pairs with adjacent vertical strokes.

Hewson (1988) noted that it isn't worthwhile kerning any type under 18 points. Kerning is important for headings in

books, handouts, pamphlets, reports and other printed documents, and also for texts on OH transparencies, PP presentations and wall charts.

There may be too much space between the letters in large fonts (upper example). Here it is necessary to apply kerning (lower example) and correct the distances between characters to achieve a more legible type.

Hyphenation

Lines can be broken according to different principles. According to one principle, lines can be broken only between words. According to another principle, lines can be broken also within words. This can be done phonetically or according to etymology. In mechanical word breaks, lines are broken at the most convenient point, regardless of meaning. It is known that poor readers have difficulty reading hyphenated text (Gregory and Poulton, 1970; Lichty, 1989; White, 1983). Misanchuk (1992) provides guidelines for hyphenation.

Rules
Vertical and horizontal straight lines that are used in typography and layout are called rules. Horizontal lines can be used to separate sections in a text and rows in a table. Vertical lines can be used to separate columns of text on a page or columns in a table. It is; however, often better to use white space as a separating device. Rules wider than 12 points are called bars or bands. Sometimes horizontal bars have type in them. Rules may be in colour.

Headings

Headings, or *headlines*, attract the attention of the readers, enhance the hierarchic structure, make the subject matter readily apparent, and indicate the relative importance of items.

Show structure
Headings should be used to make the subject matter readily apparent, and indicate the relative importance of different items in the document (Cisotto and Boscolo, 1995; Jonassen, 1982; Mayer, 1993). Composition, intentional use of size, space, and placement of headings enhance the hierarchic structure in information material and help the readers to get the message (Jonassen, 1982; Wileman, 1993, p. 88). Headings should always be relevant and identify the subject matter. The purposes of headings are to attract the attention of the readers, make the subject matter readily apparent, and indicate the relative importance of items. Headings in large type may be printed in colour. In order to increase the contrast it is a good idea to use larger as well as bolder type when headings are printed in colour.

Headings on different hierarchic levels will provide the readers with reference points and help them organize information cognitively for better retention and recall.

To achieve a clear structure we can use a combined numbering and lettering system (Jonassen, 1982). Main points in a text are traditionally labelled with Roman numerals (I, II, III, IV etc.). Sub-points of the first degree are traditionally labelled with capital letters (A, B, C, D etc.). Second-degree sub-points are traditionally labelled with Arabic numerals (1, 2, 3, 4, etc.). The labelling hierarchy is I., A., 1., a., (1), (a). In Europe it is common to use a numbering system only (e.g., 1, 1.1, 1.2, 1.3, 1.4; 2, 2.1, 2.2, 2.3, 2.4; 3, 3.1, 3.2, 3.3, 3.4 etc.).

Size and style

We can vary the type size and/or use different type versions. According to a rule of thumb, called the "Rule of X's," the height of the uppercase X of a smaller typeface should be the same as the height of the lower-case x of a larger typeface in a hierarchy. For a ten point running text headings may be 10, 14, 18 and 24 points. For a twelve point running text headings may be 12, 16, 22 and 28 points.

Numbering and lettering systems can be combined with typographic cueing of headings. Headings set in different type versions aid comprehension of the material. We can use a special typeface for headings, for example a sans serif typeface like Avant Garde, Futura, Gill, or Helvetica.

Headings set in different type versions aid comprehension of the text content (Jonassen, 1982; Mayer, 1993). However, such a mix appears strange to some European readers. In Europe there are national differences concerning the use of typefaces with and without serifs. Scandinavian newspapers, for ex-

ample, often use Modern Style typefaces, whereas England and France prefer Transitional Style or Old Style typefaces. In Germany they have serif as well as sans-serif typefaces.

Placement of headings

The use of space and the actual placement of a heading can be used to enhance the hierarchic structure (Jonassen, 1982). Headings shall be placed above and close to the following text. This distance shall be smaller than the distance to the previous paragraph (Pettersson, 1993; Lipton, 2007). Sometimes headings are indented.

We need to provide space enough for the headings in a text. The amount of white space surrounding headings should correspond to the heading hierarchy. A major heading needs to have more space than a minor heading.

The distance between the heading and the text below the heading should always be smaller than the distance between the heading and the previous text (the text above). The heading "belongs with its own text". See the two examples on the next page. In each case the total space for the heading is the same but the positions of the headings are different. Distinguishing headings with extra white space makes a document easier to search and easier to read. See the two examples on next page.

Example 1

A major heading needs to have more space than a minor heading We need to provide space enough for the headings in a text.

Good placement

The distance between the heading and the text below the heading should always be smaller than the distance

Example 2

A major heading needs to have more space than a minor heading We need to provide space enough for the headings in a text.

Bad placement

The distance between the heading and the text below the heading should always be smaller than the distance

Paragraphs

There are a few possibilities to emphasize paragraphs. Paragraphs may be indented and/or separated with extra space for emphasis.

Paragraph indents

An indent is the distance between the lines in a text and the text-face, usually the right part of the left margin. Paragraphs may be indented and/or separated with extra space. *First line indents* are the distance between the beginning of the first line in a paragraph and the left margin. They are often used for the running text in books. There are also *negative indents, hanging indents, nested indents* and *full paragraph indents*. It is considered to be bad typography to allow an indent on the bottom line of a page. To avoid this it might be possible to edit the text until it fits.

First line indents

In order to emphasize the beginning of paragraphs in running text the first lines may be indented and start with empty spaces. The width of an em dash is commonly used for paragraph indentation. This width is equal to the height of the type. So in 12 point Georgia an em dash is 12 points wide. However, other widths are also common. The fragment below demonstrates a first line indent, here marked with a blue rectangle.

The width of the first line indent in this paragraph is marked with a blue rectangle. In this book first line indents are used in all paragraphs, with the exception of paragraphs following headers and certain citations. Headings may be indented.

According to Tinker (1963) indenting of the first sentence of each paragraph improves legibility by 7% for both single and double line spacing. According to Frase and Schwartz (1970) indenting the first sentence of each paragraph improves comprehension of printed materials. Indenting of every sentence will, however, slow down the reading speed.

Negative indents

The indent on the first line of a paragraph may also be directed back into the left margin (or sometimes even forwarded into the right margin). This is called a *negative indent* and may be used for reference lists, numbered lists and lists with bullets, and other characters like stars, squares etcetera. The fragment below of a paragraph demonstrates a first line indent.

The first line in this paragraph starts in the left margin. This is an example of a negative indent, here marked with an “empty” space. The following lines will align with the margin. Headings may have negative indents.

Negative indents may also be used in texts where it is very important to draw attention to each new paragraph. However, as noted above, indenting of every sentence will slow down the reading speed.

Hanging indents

Hanging indents, or *outdentions*, are often used in reference lists, numbered lists and lists with bullets, and other characters like stars, squares etcetera. All lines, except the first lines, begin with an empty space. In contrast to texts with negative indents all the texts always remain within the text column. Indents make it easy to find single references.

The fragment below of a ”reference list” demonstrates hanging indents, here marked with blue rectangles.

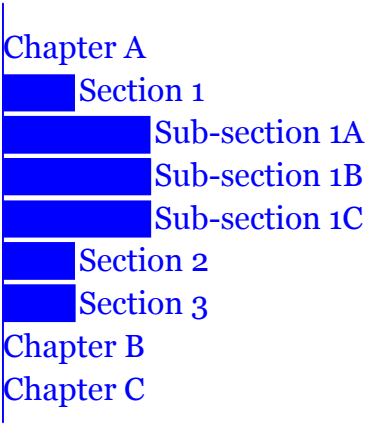
Pettersson, R. (1989). *Visuals for Information: Research and Practice*. Englewood Cliffs, NJ: Educational Technology Publications.

Pettersson, R. (1993). *Visual Information*. Englewood Cliffs, NJ: Educational Technology Publications.

Pettersson, R. (2002). *Information Design, An introduction*. Amsterdam/Philadelphia: John Benjamins Publishing Company.

Nested indents
Nested indents are a form of indention in which each subsequent indent is set relative to the previous indent, and not relative to a margin. Nested indents may be used to graphically show the relationship between chapters, sections, sub-sections and paragraphs within a text. Tables of contents often have nested indents to show each successive level.

The fragment below of a ”tables of contents” demonstrates nested indents, here marked with blue rectangles.



Full paragraph indents
Long quotations should be distinctly separated from the rest of the text. Quotations are often indented, sometimes also on the right side. Full paragraph indents may also be used for lists and tables. See the section *Quotations*.

Extra space
Readers prefer small text paragraphs to big ones. Often it is quite easy to divide the text in hierarchic and natural parts, portions, or sections. Natural breaks emphasized by typography are helpful. Providing “extra white space” between paragraphs and

between larger portions of the text provides valuable cues to the learners that a new section or a new type of activity follows (Waller, 1987). The extra space between paragraphs may vary, depending on the material.

Marks

The end of a sentence should be determined by syntax rather than by a set width of a line (Hartley, 1980; Bork, 1982). There are usually no problems with continuation of text in books. The text fills up page after page, and chapter after chapter. However, in magazines and other periodical publications, it is sometimes necessary to use special *continuation marks*. These marks may be arrows or triangles and references to page numbers. In these situations it might also be a good idea to use *terminal marks* after the last paragraph in the article. Such a mark is often a circle or a square, filled or unfilled. Sometimes the terminal mark is the initials or the signature of the writer.

Tables

Numeric data can be used to illustrate several different situations, such as chronological changes in single quantities or sets of quantities, parts of a whole, and relationships between two or more variables.

There are different ways to present numeric data. In print media numeric data can be presented in text, as figures and digits, in tables, or in various graphical formats. No more than one or two items of numeric data should be presented in prose form. Tables are often, but not always, a good solution. Tables may show the maximum of amount of information in the minimum amount of space.

Many people find tables confusing and difficult to understand (Wright, 1968). Tables should be structured and compact for easy accessibility. Sometimes a diagram or a graph may be a better choice.

Vertically oriented tables

The following three examples, Table 1, 2 and 3, demonstrate how vertically oriented tables may look. In these examples the data that are used has no interest at all. Table-titles are often, but not always, put above the actual table. They include descriptions of the table contents. However, in these examples the table-titles only comment on the design of the table below.

Table 1. This is a vertically oriented table. Ruling in the table is thin.

Products	*Sales in $*		
	2012	*2013*	*2014*
Product 1	100	120	110
Product 2	200	180	210
Product 3	200	220	210
Product 4	300	320	350
Product 5	400	420	410

Table 2. This is a vertically oriented table without ruling.

Products	*Sales in $*		
	2012	*2013*	*2014*
Product 1	100	120	110
Product 2	200	180	210
Product 3	200	220	210
Product 4	300	320	350
Product 5	400	420	410

Table 3. This is another vertically oriented table without any ruling. However, in this case the columns are very wide. The large distance between the numerical data in the columns makes it hard to read the table below.

Products	*Sales in $*		
	2012	*2013*	*2014*
Product 1	100	120	110
Product 2	200	180	210
Product 3	200	220	210
Product 4	300	320	350
Product 5	400	420	410

Readers prefer vertically oriented tables rather than horizontally oriented tables. In vertically oriented tables it is easy to see the target entries, and then quickly find the data in the table cells to the right (Wright, 1968; Wright and Fox, 1972; Ehrenberg, 1977). It is easy for us to compare data “side by side.”

Horizontally oriented tables

The following three examples, Table 4, 5 and 6, demonstrate how horizontally oriented tables may look. As in the previous examples of tables the data has no interest at all and the table-titles only comment on the design of the tables.

Table 4. This is a horizontally oriented table. Ruling in the table is thin.

Sales in $	*Products*				
	Product 1	*Product 2*	*Product 3*	*Product 4*	*Product 5*
2012	100	200	200	300	400
2013	120	180	220	320	420
2014	110	210	210	340	410

Table 5. This is a horizontally oriented table without ruling.

Sales in $	*Products*				
	Product 1	*Product 2*	*Product 3*	*Product 4*	*Product 5*
2012	100	200	200	300	400
2013	120	180	220	320	420
2014	110	210	210	340	410

Table 6. This horizontally oriented table is not only very ugly, it is also very confusing and provides very poor legibility. Please note that all the data are the same as in previous tables.

Sales in $	Products				
	Product 1	**Product 2**	Product 3	*Product 4*	Product 5
2012	100	200	200	300	400
2013	120	180	**220**	*320*	420
2014	110	*210*	210	340	410

Horizontally oriented tables are harder to use and more difficult to understand than vertically oriented tables (Wright, 1968; Wright and Fox, 1972). It is complicated to compare data "up and down."

Good tables

Tables that communicate the quantitative aspects of data are effective only when the data are arranged so that their meaning is *obvious at a glance* (Ehrenberg, 1977). After deciding what data to present but before design a table, we need to consider that (a) rounded-off values may display patterns and exceptions more clearly than precise values, (b) a reader can compare numbers down a column more easily than across a row, and (c) column and row averages can provide a visual focus that allows the reader to inspect the data easily.

According to Tinker (1963) the type used in tables should be no smaller than 8-point, and no larger than 12-point (Tinker, 1963; Wright and Fox, 1972, p. 241). Like pictures, all tables

should be integrated with the text content, in the flow of text. In a text, tables should preferably be put between paragraphs, and not forced to break paragraphs and thus disturb the reading. Sans-serif typefaces are usually used in tables. Good examples are Helvetica and Franklin.

In *friendly graphs* (Tufte, 1983; 1990), words are spelled out, they run from left to right (in western societies), and data are explained. Elaborately encoded shadings, cross-hatching, and colours are avoided. Colours are easy to distinguish, type is clear and precise, and is done in upper and lower case with serifs. In *unfriendly graphs*, abbreviations abound, words run in many directions. Graphics are repellent and cryptic with obscure coding. The design is insensitive to colour-deficient viewers Red and green are used for essential contrasts, and type is clotted and in all capitals in sans serif.

Wright and Fox (1972) offer the following guidelines for the construction of tables for the general public and non-professional audiences (p. 241):

- All the information the learner will need should be presented in the table. That is, the learner should not be required to interpolate, combine entries, draw inferences, or otherwise manipulate the contents of the table in order to determine the correct answer. Rather, the learner should only be required to scan the list to find the correct target entry.
- Type size used in the table should be between 8 and 12 point.
- Items should be arranged vertically in the table rather than horizontally (i.e., the list of target entries should be vertical).
- Items within columns should be grouped and separated from other groups by either white space or rules (lines) in

order to facilitate reading without accidentally moving to another row. Groups should contain no more than five items.

- Redundant abbreviations of units should not be included within the table entries [although they should be included in the column or row headings].
- 'Landmarks' or sub-headings – certain target entries in the table highlighted by using bold type or a larger font (e.g., every tenth entry, starting with 10, 20, 30, etc.) as an intended aid to locating entries – should not be used, since they appear to be ineffective and possibly confusing.
- It is useful to have adjacent columns printed in different fonts or styles to distinguish between them. That is, there is less chance of erroneous reading of the table if the column of target entries is in normal text (for example) and the column of associated answers is in boldface text.
- Related pairs of items in adjacent columns should be spaced closely together (i.e., the eyes should not have to traverse a great distance between the target entry and the associated answer).
- Whenever possible, columns should be arranged so that the target entries are to the left of the answers.

Ehrenberg (1977) provides some more general guidelines for the construction of tables for the general public and non-professional audiences:

- Numbers should be rounded off to no more than two significant figures to facilitate learners' making comparisons.
- Averages of rows and columns (as appropriate) should be given to facilitate learners' making comparisons of individual cell entries to them.

- Put the most important comparisons into columns (rather than rows), as columns make for the easiest comparisons.
- Numbers in rows or columns should be arranged in some meaningful order whenever possible (e.g., increasing or decreasing).

Bigwood and Spore (2003, 2013) discussed how to present charts, numbers, and tables for easy communication. They provided the following six rules of plain figures:

- Put figures in a logical order, often from the largest to the smallest.
- Add focus to figures. *Arithmetic means* and *medians* make it easier to see exceptions and patterns in the data. *Percentages* show proportions. *Totals* provide overviews.
- Keep numbers to be compared close. This proximity aids comparisons.
- Round figures for clarity. In many situations exact numbers, with four decimals, does not matter. It may often be a good idea to use variable rounding and convert exact numbers to two, or three, effective digits, regardless of the size of the number.
- Provide written summaries in the text of the charts, numbers, and tables.
- Use layout to guide the eye, and avoid distracting and unnecessary decorative elements that interfere with the content in graphs.

Table 7. This vertically oriented table provides good legibility. However, sometimes more lines are needed.

Products	*Sales in $*	
	2013	*2014*
Product 1	100	120
Product 2	200	180
Product 3	200	220
Product 4	300	320
Product 5	400	420

There are obviously many ways to design even a simple table. It is easy to agree with the *Publication Manual of the American Psychological Association* (1996, 121) where the American Psychological Association concludes "that an author's thoughtful preparation makes the difference between a table that confuses and one that informs the reader."

Captions

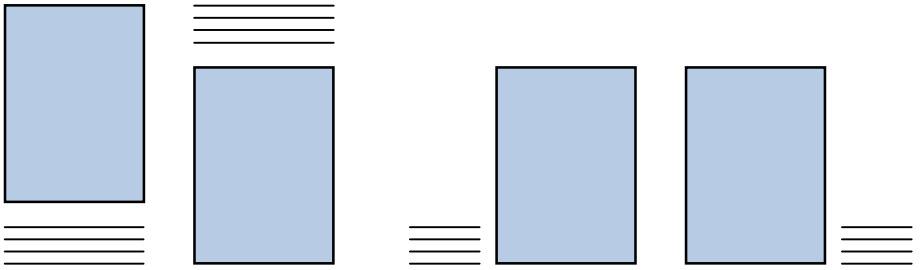
Most pictures are capable of several interpretations until anchored to one by a caption (Barthes, 1977). McDougall and Hampton (1990, p. ix) concluded that photographs nearly always need a partnership with words that will confirm, clarify and reinforce their messages.

Placement of caption

Each picture should have its own caption, unless two pictures or a series of pictures are closely together. A caption may be placed in many ways. The caption should always be located close to the

picture. Readers usually expect to find the captions beneath the pictures. However, captions can also be placed above, to the left, or to the right, of the picture, but never inside the picture frame. Use flushed right text if you want to put the caption to the left of the picture. Use flushed left text if you want to put the caption to the right of the picture. When the caption is put above or beneath the picture, we can use justified text or flushed left text and sometimes even centred text. Sometimes triangles or arrows pointing from the caption towards the picture are used, especially when pictures are gathered together many on a page, e.g., in a magazine.

Placing the caption inside the picture makes it harder for people to read the picture as well as the text. Nor should the caption be located on some other page, as happens far too often in reference books and textbooks used in schools.



Here are different ways to place captions. Readers usually expect to find captions beneath the picture as in the first example to the left.

Typography of caption

The caption should have a different typographic size or even a different typeface so it can be easily distinguished from the main text. The captions should not be in negative form in a colour picture since the slightest misalignment in printing makes

the captions extremely difficult to read. Never make the caption type larger than the main text. The title of the caption could be printed in boldface.

(See the book *Information Design 2–Text Design* for further information about captions.)

Quotations

Sometimes quotations are included in a text. Short quotations can be integrated into the body text, but long quotations should be distinctly separated from the rest of the text. Quotations are often indented, sometimes also on the right side. Any quotation that is used must have the source of reference cited, in keeping with common rules of writing. Below is an example of a short text segment (blue) with an embedded quotation (here green). The *full paragraph indent* is shown with a blue rectangle.

On occasion, unfortunately, communication does not seem to function. This may depend on insufficient information, but it may also be because we have difficulty reaching each other. By way of example, the following text is cited as a warning in *The Technical Writer's Handbook* by Young (1989, p. 206):

> Conditional symbolic modified single-digit arithmetic using optical content-addressable memory logic elements: Conditional symbolic modified signed-digit arithmetic operators.

Esoteric and impenetrable jargon like this can be perceived as incomprehensible by the uninitiated. Since readers who do not know the code are left out, its use poses the risk of 'one-way-only' communication, and has no value outside of initiated circles.

In this example, the body text and the quotation are set with 12 point Georgia with 16 point line spacing. Quite often the quotation is set in a smaller type. Between the text and the quotation, there are spaces that each corresponds to half a line, in this case eight points. Blank space (blank lines) like these can be used in various contexts to provide space above and below, for example, pictures, tables, and lists. In fact, we may use “empty lines” for vertical separation of text elements rather than printed lines of any kind. In this book the firsts paragraphs below quotations and examples are not indented.

Lists

Putting information into list form can facilitate comprehension (Hartley, 1987; Frase and Schwartz, 1970). There are several types of lists used in technical documentation. A book, for example, usually contains a table of contents, a subject index, and a bibliography. It may even contain lists of pictures and tables, or of authors or other persons. The text in the book may have various lists of characteristics, criteria, requirements, or prospects. Within a body text, there may be various lists of characteristics, criteria, items, requirements, persons, and products. Bullets and numbers are used for items of the first degree. Hyphens are used for lists within such a list. In a numbered list, the various items are ordered according to their importance, unlike the unnumbered list. In an unnumbered list items may be ordered alphabetically, or not at all. It is also possible to use upper case letters or upper case roman figures for items of the first degree, numbers in Arabic figures for the second degree, bullets for the third degree, and hyphens for the fourth degree.

Table of contents

The table of contents may have justified or unjustified text. The important thing is that the structure of the content in the document is clearly visible to the reader.

The table of contents immediately follows heading level one, ("Contents") and may be set in 12 point normal type with 14 point line spacing, left-aligned, and without any extra space before each entry. Chapter designations may be set in bold face, while section designations usually are set in normal typeface. Page-numbers follow each text on the same line. They may also be flushed right.

When a table of contents is extensive, it may be rendered in two columns. References to page numbers are often shown for heading levels one, two and three, with indents for each successive level. Heading levels four and more are usually not shown in a table of contents. This would impair the possibility to get an overview and understanding of the overall structure.

Bibliographies

References to cited works are usually put in a reference list at the end of a chapter or at the end of a book. When each chapter has its own bibliography, the heading "Bibliography" or "References" may be set as a heading 2 in the document. When there is only one bibliography for a factual study book, heading level 1 is used.

Bibliographies are often voluminous and may take up a great deal of space. Since the reader will usually peruse such a list to find only certain entries, they should be made easy to find. Therefore, the text should be distinct even though it is relatively compact. One common bibliography may be a good

idea when several references are the same in more than one chapter.

In a printed book bibliographies may be set in ten point type with 11 point line spacing, with 12 point negative indents. Above them, there may be 2 or 3 points of space, but no extra space is needed below. Indents make it easy to find single references.

A bibliography may be laid out to cover the full width of the column. If the bibliography is very extensive we should divide it into two columns that are equal in size, even if the body of the text in the document is arranged in one wide column.

The subject index

A well-constructed subject index, "Index," is often an indispensable tool for quickly finding information in books. As is the case with bibliographies, the readers are usually looking only for certain information when they refer to a list of this kind.

A subject index may be set in three 50-millimetres-wide columns, in ten point type on 11 point lines, with 12 point indents. It is not necessary to have extra space between the lines. However, there may be a half a line of space between groups of words that begin with successive letters of the alphabet. The title of the subject index may be set as a header 1.

Lists of items

Within a body text, there may be various lists of characteristics, criteria, items, requirements, persons, and products. Bullets and numbers are used for items of the first degree. Hyphens are used for lists within such a list. In a numbered list, the various items are ordered according to their importance, unlike the unnumbered list. In an unnumbered list items may be ordered alphabetically, or not at all. It is also possible to use upper case

letters or upper case roman figures for items of the first degree, numbers in Arabic figures for the second degree, bullets for the third degree, and hyphens for the fourth degree.

Notes

Notes tend to fray the reading fabric. If notes are required, they may be collected in a numbered list at the end of each chapter immediately before the bibliography, and arranged like a list of items with numbers instead of characters to mark them. Occasional notes and brief references may be placed as *footnotes* at the bottom of the page, or sometimes in the left or right margin or at the end of the chapter or article. Usually a smaller type size or a different typeface is used for footnotes. A horizontal line can separate the footnotes from the running text. When there are two or more columns on a page footnotes should be placed at the end of the document

The title pages

A book begins with a title page with the title of the book, the name(s) of the writer(s), and the name of the publisher. On the second page, the imprint page, administrative information such as the name of the document, a document number, a security classification, revision or version number, and date of publication may be provided at the top of the page. Information about the ISBN- or the ISSN-number and the copyright holder are usually provided at the bottom of the imprint page. There are usually no pagination on the title and imprint pages.

On the third page in a book, there is the *preface*. The header “Preface” may be set as heading one. A preface will usually not exceed two pages. Page three is usually the first page with pagination. On the fifth page, or the first odd page after page five, the table of contents starts. The header “Contents”

may be set as header one. However, in e-books intended for reading on screens the table of contents may start on page four.

The pages with preface and table of contents are often paginated with lower-case roman figures. The book is numbered with Arabic figures.

Miscellaneous

This section contains short notes on a limited number of items in graphic design.

Abstract, a short summary of a paper put in the beginning, below the author lines and above the body text.

Achromatic colours are black and white.

Active space or *positive space* in a visual is the part representing different objects. Space has no meaning in itself, but it may be used to separate or bring together different picture elements.

Agate lines are vertical measurement of space, there are fourteen agate lines to an inch.

Artistic layout may please the individual artistic graphic designer, but may have no relation to the content of the message.

Ascender. The part of a lower case letter (b, d, f, h, k, l) that ascend above its x-height. These letters may be taller than the cap height.

Author lines are the lines at the beginning of a paper with the name of the author or the authors. It is often centred and set in smaller type than the heading.

Balance is the sum of all the elements, the verticals and horizontals, the darks and lights, that make up the design.

Bleed is text and/or pictures that extend beyond the trim edge of the printed page.

Blowup is an enlarged picture.

Bold type, or boldface, members of a family of type in which letters are heavy, **bold**.

Borders are ornamental rules around the edge of a page or a page component.

Boxes.

Specially important messages like summaries can be boxed-in to gain special attention. If the lines are shorter the effect is even more obvious. Boxes usually have thin lines. Boxes may sometimes be filled with a background colour.

Bullets (•) are commonly used in lists of items in "point form" without numbers. Bullets are more powerful than hyphens (-) or asterisks (*).

Camera-ready is a final printout of a page with text and pictures that is ready for reproduction, and also or art that is ready for reproduction.

Cap height or H-height. The size of capital letters in a typeface, expressed as a percentage of the point size. (See illustration in chapter 2.)

Capital letters, *caps*, are harder to read than a combination of upper and lower case letters.

Caps is short for capital letters.

Check box. Check boxes (☐) can be used in instructional materials when learners may make check marks when they have finished assignments.

Chop-mark is the symbol of a printer specializing in printing of fine arts, such as etchings, etc.

Chromatic colours are blue, green, red and yellow.

Colour-key is a process for obtaining process colours on film by exposure to light.

Colour-spacing. Positioning letters so that balances of negative and positive spaces are pleasing.

Column is a vertical segment of a printed page.

Column rules are vertical lines between two columns.

Condensed. Horizontally narrow type designs.

Continuous-tone is a complete range of gray, from black to white.

Contrast is the result from differences along a common visual dimension that can be observed between various elements in a design.

Copy is usually the text in a design, but also all the elements of a finished design.

Credits. In books it is quite common to give credits to artists and photographers in a special “List of illustrations”. In magazines and in newspapers credits are usually put next to the ac-

tual illustration, often in a vertical position. Credits to the author are usually in the form of a byline.

Cutoff rules are horizontal lines that separate unrelated items above and below the line.

Cyan, the particular blue used in four colour process printing.

Dash. With the typewriters we had to create a dash (—) with two hyphens (--). With desktop publishing and typography this is not necessary. In 12 point Georgia the em dash is 12 points wide. In desktop publishing we can create the em dash or em rule (—), the en dash or en rule (–), as well as the hyphen (-). The em dash is used to indicate a break in thought. There should be no space before or after the em dash. The en dash is used between numerals (e.g., pp. 33–45 and as a minus sign (e.g., –12).

Descender is the part of some lower case letters (g, j, p, q, y) that descend below the baseline.

Didot system, a system for measuring size in typography, 12 points = 4.511 mm.

Differentiation. It is essential to be able to differentiate elements from one another.

Disinformation is the opposite of information design.

Dot. A dot is a full stop (.) to mark the end of a complete sentence.

Drop caps are lowered initial letters.

Dropout is a halftone in which no dots fall on white areas.

Dust cover or jacket is the paper wrapper of a hardbound book.

Ellipsis. An ellipsis (...) is normally used to indicate that a part of a text is missing in a quotation.

Em is the square of the body of type. See Dash.

Extended. Horizontally wide type designs.

Face is the printing surface of type; also, any particular style of type.

Fill-in blanks. Fill-in blanks (_) can be used in assignments, and in lists of various kinds, for people to mark their choices.

Folder. A folder consists of a single sheet, usually printed on both sides, and folded two or more times.

Font of type is a complete assortment of characters of the same style and size. However, in computer manuals the word *font* is sometimes used to mean typeface, which is confusing.

Footers. When present, footers appear at the bottom of every page. Like headers, footers may carry page numbers.

Formal balance has total symmetry and it is felt to be static and harmonious. It may, however, also be boring. Composition can be used to direct the viewers.

Glossy is a reproduction proof of type.

Graphical media include products such as almanacs, catalogues, children's books, dictionaries, educational materials, encyclopaedias, forms, graphic symbols, handbooks, indexes, maintenance information, manuals, maps, non-fiction books,

plans, product descriptions, reference books, reports, textbooks, and tickets.

Graphics editors work on schematic pictures that are delivered by subject matter experts and writers. They produce finished schematic pictures.

Grid, a geometric pattern used as a base for layout.

Grouping. By grouping headings, paragraphs, illustrations, and captions, the designer aids communication.

Gutter. The margin at the binding edge of a page, or inside edge of unbound pages.

H-height, or *cap height*, is the size of capital letters in a typeface, expressed as a percentage of the point size.

Hairline. A hairline is the finest line in metal type. Hairlines are often used to divide columns.

Halftone. A halftone is a reproduction in which tones have been photographed through a screen. The picture is divided into dots. Size of dots governs darks and lights.

Hanging indent, or *outdentation,* is the reverse of indentation. Examples are lists with bullets.

Harmony describes the effect of the pleasing interaction of all the design elements in a design.

Headers. When present headers, or running heads, appear at the top of every page. Like footers, headers may also carry page numbers.

Hot type, *hot lead typesetting, hot metal typesetting, mechanical typesetting, metal type*, refers to 19th-century technologies for typesetting text. Hot melted type metal is injected into moulds. The resulted characters are used for printing ink onto paper.

Interest. Scale, contrast, and colour may add visual interest to a design.

Interline distance is the vertical distance from one baseline to another baseline in a text.

Introductions to chapters in a book or to articles in a magazine or a newspaper are very often set in different type than the following running text. Sometimes the introduction is set with larger type size, sometimes in italic or bold typefaces.

Italic type, *italic*, or *italics*, are members of a family of type in which letters slant to the right. Italics are designed to complement the normal vertical design. See the section *Stylistic variation of type*.

Jacket or *dust cover* is the paper wrapper of a hardbound book.

Jim dashes are short cut-off rules that separate unrelated items above and below the line.

Kern (verb) manually adjusting the space between characters to achieve better legibility, (noun) the amount of space added or subtracted in the process. See the section *Spacing*.

Leading, spacing between lines in a text. See the section *Interline distance*.

Letterform is the design of individual characters of a typeface.

Letterhead is the top of a designed writing paper.

Letterspace (verb) to add extra space between letters; (noun) the amount of extra space added.

Ligatures. Ligatures are letters combined to new characters. Examples are Æ (A+E) and Œ (O+E).

Line length is the horizontal measure of a line.

Line space is the vertical distance from one baseline to another baseline. See the section *Interline distance*.

Lines. Various lines are often used for decoration to make a more aesthetically pleasing or artistic product. However, lines can also be used to aid communication.

Horizontal lines can separate sections or paragraphs or hold them together. Horizontal black lines are usually one to four points. When horizontal lines are printed in other colours they may be wider.

When two or more columns are used on a page, vertical lines can be used to clearly separate the text blocks from one another. By tradition vertical lines are thin, usually half a point or one point.

Linotype is a machine for setting hot type line by line.

Lithography is a printing process based on the fact that oil and water don't mix.

Lower case is the un-capitalized "small" letters of the alphabet (a, b, c etcetera).

Magenta is the particular red used in process printing with four colours.

Margins are the areas surrounding the text and pictures on a printed page. See the section *Text layout*.

Modern type is a typeface with thin, flat serifs. See the section *Typefaces*.

Moiré is an undesirable pattern in a picture that occurs by re-screening halftone copy.

Monotype is a machine for setting hot type letter by letter.

Negative space is the space between and around pictures, and also between the elements within a picture.

Oblique is an "artificial italic." It is formed by electronically slanting a vertical typeface. Italics, however, are specially designed.

Offset is a kind of lithographic printing in which ink is transferred to a rubber blanket, then to the paper.

Open ended boxes are boxes with rules only at the top and bottom.

Ornaments. Various ornaments and patterns can be used to separate different sections in a text. In instructional materials they are often used to mark specific activities. They can also be used for decoration, to make a more aesthetically pleasing or artistic product. Dingbats is a special PostScript font in desktop publishing systems

Outdentation, or *hanging indent,* is the reverse of indentation. Examples are lists with bullets.

Point, is used for measurement of letter size, see the section *Size of type*.

Pointers are lines combining labels with elements in a picture.

Primary colours, red, yellow, and blue; all others can be mixed from these.

Process colours are magenta, cyan, yellow and black. These are the inks used in four-colour process printing.

Quotation marks, ‘ ’ “ ” « », are used according to the different standards in different languages.

Rough is a preliminary layout.

Rules are vertical and horizontal straight lines used in typography and layout.

Run-arounds. When text is “wrapped” around an irregularly shaped illustration this is known as a “run-around.” Run-arounds almost never represent any improvements and should be avoided.

Sans serif is a typeface without serifs.

Scale describes the relative size or magnitude of a given design element in relation to other elements and to the design as a whole.

Separation. Use of separation devices such as bullets, numbers, and letters facilitate recall of information in list form.

Serifs are the terminal strokes, normally at the top and bottom of the main strokes of letters in a Roman type style.

Shaded letters have strong three-dimensional quality by use of heavy shadows on one side of main stroke.

Small caps or small capitals are an alternative set of capitals used for text setting. These SMALL CAPITALS are smaller than standard CAPITALS.

Special designs. Chemical, mathematical, astronomical, and medical signs are important for use in these subject matters.

Spreads are two facing pages in books, etc.

Subscript is a character set lower than the body of text, like the figure 2 in x_2. See *Superscript*.

Summaries. Important messages like summaries can be boxed-in to gain special attention. If the lines are shorter, the effect is even more obvious. Boxes usually have thin lines. Boxes may sometimes be filled with a background colour.

Superscript is a character set higher than the body of text, like the figure 2 in x^2. See *Subscript*.

Symbols. Various symbols can be used to aid communication in a book or a magazine. An example is a mark for continuation (>). Many ornaments may be used as symbols.

Title Case, each word begins with a capital letter, is sometimes used in titles and in figure texts.

Type. The term *type* refers to all characters that are used in printing. See the section *Typefaces*.

Upper case is a term for capital letters of the alphabet (A, B, C etcetera).

x-height is the vertical distance equal to the height of lowercase letters such as x (without ascenders and descenders).

Layout of text and pictures

A typical page in a telephone directory is almost filled with text. There are no pictures, and margins are narrow. The text may cover 90 percent of the page. In dictionaries the text covers 75-80 percent, and in specialist books and factual study books the text often covers 50-60 percent of the page. In pure literature and children's books, the text area is often even smaller than that. When a picture covers the entire page, there is no space for text or margins. The third extreme is an empty page.

Different layouts

A picture without a caption has no or almost no informational value. A picture is too ambiguous on its own. A picture caption must describe the picture and guide the reader to the interpretation the informer wished to convey to the reader. Both words and pictures may possess an emotive force that is not easily foreseen. A number of different value judgments may slip into a text when the purpose of the text is merely to supply information.

The reader's emotions may be aroused by seemingly insignificant details in a visual or nuances in the wording of a text. So sufficient effort must be invested in the editing of both texts and pictures. Interest can be focused on the central message in pictures through careful picture selection and editing, primarily by means of cropping, which is, deleting non-essential portions. Sometimes different visuals benefit from being presented in a group. This may be the case for a photograph and an explana-

tory drawing, or several photographs or drawings forming a mini-series or related picture sequence.

When texts and visuals are collected for informative pages and spreads, "message transmission" must be a central consideration. As previously noted this kind of "information layout" differs from a "decoration layout" in which purely aesthetic aspects are allowed to predominate.

The preparation and production of maps is called cartography. The product of a cartographer's efforts is a mathematically defined depiction of a reality based on measurements. Maps describe reality and shed light on a number of conditions, such as terrain, political subdivisions, the prevalence of certain types of soil, minerals, etc. The utilization of variations in shape and colour creates map symbols that provide a picture of the reality they represent. A carefully processed map contains more information per square inch than any other form of printed information.

In newspaper layout many different messages have to be communicated. The problem is to communicate a series of disconnected messages of infinitely varying significance within a limited space, time, and economy with a recognizably consistent style for each section of the paper. Many readers will only spend time on a limited amount of information in a newspaper. It is known that elements like headlines, photos, drawings, and information graphics attract attention and often are entry points into a page. Size and placement of such elements influence how the reader will read a page. It is possible that many readers may jump over too large pictures and never look at them at all. In magazine layout visuals are often very large.

Quite often the visuals have no or a very limited contact with the text. Here White (1987) asks for less typographic

amusement and more serious character building. Fiction layout certainly does not work very well in instructional message design. However, even in traditional non-fiction publishing, it is often very hard to access the information.

Picture placement has very often been based on aesthetic rather than instructional characteristics. The appearance of elements on the page can provide powerful cues to the reader. Thus, visuals should be located in close proximity to the parts of the text in which pictured motifs are discussed. Visuals plus their captions should preferably be inserted into the text between two paragraphs, not in the middle of a paragraph, so they do not disrupt reading rhythm.

Captions and visuals are often piled up in different areas and sometimes even on different pages. Here, an effort should really be made to achieve the best possible interplay of words and visuals. Visuals interact with the captions, other visuals, headings, running text, tables, and maps on a page and on a spread in a book, a magazine, or a newspaper. The layout of the whole spread should be attractive. However, the mere use of a lot of pictures is not at all enough. In an artistic layout, the message may actually be effectively hidden. The message is more effectively conveyed by an informative layout.

The basics for instructional message design could be summarized in the following: Select Arrangement, Balance and Colour to maximize Dynamism, Emphasis, Fidelity and Graphic Harmony.

Balance in design

In nature balance is normal. A design should usually display “good balance”. Elements of the design should fit together in an aesthetic and harmonious relationship in a manner that is in-

teresting but not distracting. Man has an intuitive sense of balance. When a single element is too large or too small, too light or too dark, too prominent or too indistinct, the entire design will suffer from this imbalance. However, good balance is something subjective. Different people may have quite different opinions on any aesthetic issues.

A composition is balanced when the visual weight of graphical elements on either side of the centre of balance are approximately equal. As with a physical balance, lighter elements can balance heavier elements if their size or value is increased, or if they are moved farther away from the centre of balance. It is also possible to move the heavier elements closer to the centre of balance. Mullet and Sano (1995, 51) noted that altering even a single attribute of one part in a complex composition could have a significant impact on the balance, the unity, and ultimately the harmony of the whole. When a single element is too large or too small, too light or too dark, too prominent or indistinct, the entire design suffers.

Imbalance creates an uncomfortable feeling in the reader and should often be avoided. Imbalance, however, can be used to attract attention within a picture or within a material. Unexpected, irregular, and unstable design will attract attention. As soon as instability is introduced in a design the result is a provocative visual expression. The eye will struggle in order to analyze the relationships and the balance within the picture.

Balance can be formal with total symmetry or informal. Formal balance is felt to be static and harmonious. Informal balance contributes to a feeling of dynamism. However, the mind needs stimulation and surprise. Contrast and imbalance can dramatize a design and attract attention. Several artists use

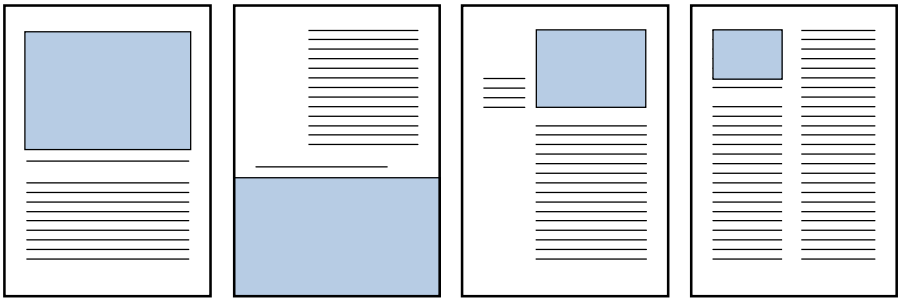
a visual strategy, such as combinations of dark and bright, large and small, round and square, to sharpen meaning.

If the lines used as pointers to elements in a picture are heavier than the lines in the picture itself this will create noise and clutter in the illustration. Pointers should be light in comparison with the lines in a picture.

Image placement

Pictures are frequent in most factual study books. A picture may be placed on a page in many different ways. It is usually, but not necessarily, adjusted to the width of the text column. A page with more than one column has more possibilities for placement of pictures. Usually, pictures are placed in a column of text, and are centred. As a rule, they may be placed where they best serve the presentation. Very small pictures can be placed in the narrow column. On the other hand, wide pictures may cover the entire text area of the page. Too many pictures will confuse the layout and reduce the chances of the reader getting involved in the text. Too few pictures appear to increase the size of the body text.

A picture may expand beyond the width of the column and cover the margins and sometimes the whole page. “Bleed” (covering the entire page, with no margins) may be used constructively and creative to expand the impact of important attention-getting images. We should avoid too much text within the pictures. The text that is absolutely necessary (that is, key words) may be set in nine point Helvetica with ten-point line spacing. Single words that are especially important or have a comprehensive function may be shown in bold face. In English texts, key words usually begin with capital letters.



A few examples of pages with text, pictures and their captions.

As previously noted many authors have noted that in materials for information a picture should be located as close to the relevant text passage as possible. It is usually a good idea to put pictures between the appropriate paragraphs in the text to get maximum impact (Pettersson, 1989, 1993). Pictures that are put within a paragraph will interfere with the reading of the text. Above the picture, there should be at least one blank line, if, of course, the picture is not at the top of the page, in which case the upper margin will provide sufficient empty space.

A picture can be tilted on the page. Tilting of a picture may draw special attention to it. Pictures on odd-numbered pages attract more attention than pictures on even pages. In newspapers and magazines it is quite often a correlation between placement of pictures and perceived importance. The higher up on a page a picture is placed, the more important it is considered to be (White, 1987). Many visuals have a built in "direction," e.g., a person on a photograph may be looking to the left. Such a picture should usually be placed on the right page for the person to look into the gutter and not out of the book or the magazine.

People who have not learned to read or write do not necessarily look at pictures in the order that has been intended by the

designer. Therefore it often proves helpful, as messages are being tested, to ask several groups of people to arrange the individual message into a sequence that seems most logical to them (Zimmermann and Perkin, 1982; Wileman, 1993, p. 105). This is a way to better get to know the intended audience.

Image framing

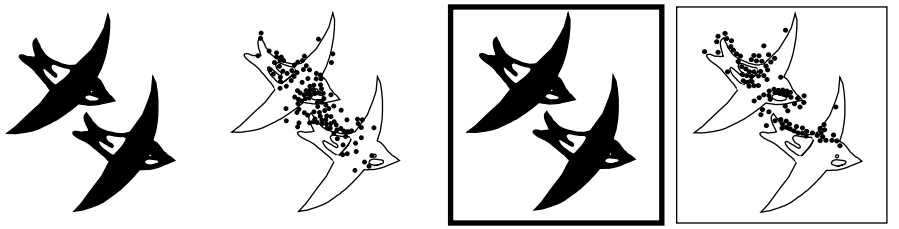
A frame or box around an image, or sometimes around an illustration and text, may have different functions. Image framing can be functional and/or attentional. A frame will separate the image from the surrounding context and draw special attention to information within the frame. In a newspaper, framing is a way of helping the readers to combine the corresponding text and pictures on the page.

Interplay of visuals

In many situations it is a good idea to use more than one visual to be able to convey information. We can use image pairs or sequences of images.

Image pairs

In many situations it is a good idea to use pairs of visuals in which one is true-to-life, such as a photograph, and the other represents an analytical representation, such as a simple line drawing. The analytical visual makes it easier for us to understand the content, and the realistic visual enables us to believe in the content. So the two visuals should be closely linked in a carefully thought-out relationship. The actual size of two pictures may reflect a natural relationship of scale, but it may also reflect a relationship of importance.

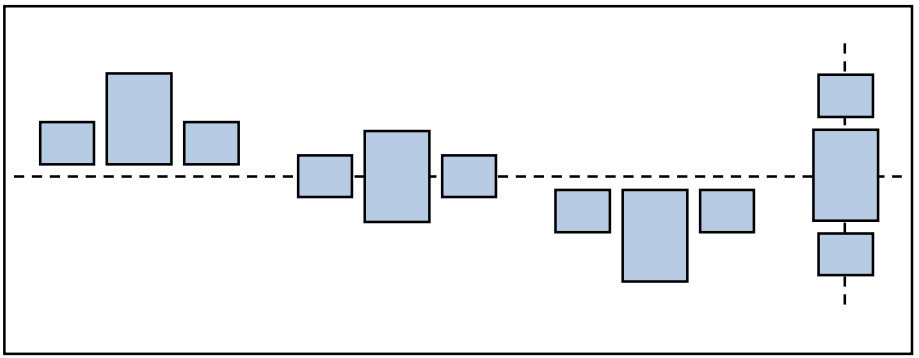


Seventeen subjects viewed a drawing of two flying House Martins. The recorded fixations have been plotted on the outlines to the right. Nine subjects viewed the version without a frame and made 117 fixations. Eight subjects viewed the frame version and made 98 fixations. Note that there are no fixations on the border in this case.

To enhance communication it is very good if there is a logical relationship between pictures placed next to each other. This relationship may be based on consistency or on continuity.

Image sequences

Usually picture editors seek a single picture that best sums up a situation. However, sometimes it is necessary to divide a message content into a series of visuals. The amount of details can be great or the content can include a certain period of time. Time scales and charts provide a reference in time and space. A sequence of pictures can be used to explain a development over time. It can be used in instructions. A sequence of pictures telling parts of the same story can be used to hold a chapter together to enhance the depth dimension in a printed material. A series of pictures can approximate the impression of a motion picture sequence. Several consecutive enlargements of a specific part will help the reader to understand the detailed structure of an object.



This example shows four ways of arranging a group of three pictures with reference to (dotted) "lines of balance". (Captions are not visible in this example.)

Understanding of a series of pictures is dependent upon the ability to recognize that the object or person in each frame is the same. For an exhibition, pictures and prints can be put on a wall or on a board in many different ways. Balance in the layout can be achieved by putting all pictures on a joint base line or bottom edge. Balance can also be achieved by putting all pictures centred on a "central" line. A third possibility is to put all the pictures on the wall with a joint upper edge. When we want to have two rows of pictures on the wall we can achieve balance with reference to a central line or cross or with reference to joint bottom and upper edges and joint side edges. A fourth possibility is to put all the pictures in a vertical sequence.

The picture area index

Evans, Watson and Willows (1987) discussed the use of visuals in Canadian textbooks. They analyzed 11,236 textbook pages. 8,304 pages had illustrations. Like Willows, Borwick and Hayvren (1981) they used two different methods of measuring visu-

als/pictures/illustrations. They calculated an "index of frequency," that is the number of pages with any visuals in percent of all pages (except title pages and indexes). The average index of frequency was 74% (8,304 pages with illustrations is 74% of all 11,236 pages). In lower grades almost all pages had illustrations (95-99%). For higher grades the index of frequency went down considerably.

In textbooks, however, many pages have more than one picture. When visuals are used for information the "actual number of illustrations" seem to be much more important than the number of pages with illustrations. A "picture index," defined as the average number of pictures for 100 pages, will no doubt be a better measure and more suited for international and intercultural comparisons of textbooks (Pettersson, 1990). It is possible to calculate both the index of frequency and the picture index from the data given by Evans et al. (1987) in their Appendices B and C. As seen from these data the index of frequency and the picture index really give complementary information about the textbooks. It is easy to see how the character of these textbooks changes from the lower to the higher grades within each group of subject matter.

Evans, Watson and Willows (1987) also indexed the sizes of illustrations according to the percentage of the page occupied by the illustrations. Illustrated pages were mentally divided into quarters and each illustration coded as occupying up to 25% of the page, 26 to 50% of the page, 51 to 75% of the page, or more than 75% of the page. For lower grades illustrations usually covered more than half of the page size. For higher grades the average picture size usually decreased.

Metallinos et al (1990) mentally divided the page into six equal parts, sixths, and indexed the sizes of illustrations in

secondary school geography textbooks. The most common size was 1/6 in Australia and Japan, and 2/6 in Greece, Sweden and the US. They defined the "average picture size" as the average part of a page covered by pictures.

It is however not enough to get information about the sizes of the pictures. We can also use an index showing how the available printed area in a book is divided between text and pictures. Thus the "picture area index" is defined as the average percentage of the text-face utilized for pictures. A book without any pictures will obviously have a picture area index of 0 (zero). When the index is 50 half of the total text-face in the book is covered with pictures. A picture area index of 100 leaves no room at all for any text in the book (except for texts printed in the actual pictures).

Some samples among textbooks for the 9–year Swedish comprehensive school showed that 60-80% of the text-face was covered by illustrations in textbooks used for elementary level (year 1.3). For intermediate level (year 4–6) the percentage was 50-70, and for senior level (year 6–9) it was 30-60, with a big difference between various textbooks (Pettersson, 1991).

Too be able to judge the quality of "mental indexing" of picture sizes and the possibility to use such data for calculations of picture area indexes the following study was done. One chapter in each of three textbooks were used and the picture area indexes were calculated with three different methods. (Melin and Pettersson studied these three textbooks with respect to captions, 1991).

Exact measurement

For each textbook the text-face was measured and calculated. Then all the pictures were measured. The heights and widths

were measured in millimetres. The areas of the pictures were calculated and added up to a total picture area. Then the picture area index was calculated. In the table below these results are called "the real picture area index".

Estimation with quarters

Based on the method used by Evans, Watson and Willows (1987) the text-faces (and not the pages) in each book were mentally divided into quarters and each illustration coded as occupying 0–1/4, 1/4–2/4, 2/4–3/4, and 3/4–4/4 of the text-face. (It is of course also easy to use a grid, drawn on a transparent foil.) Some pictures may actually be larger than the text-face. Such pictures are coded in the 3/4–4/4 category. The number of pictures within each category was multiplied by the theoretical mean size for each group (that is 12.5%, 37.5%, 62.5%, and 87.5% respectively). The added total picture area was then divided by the total text-face resulting in an "estimated picture area index".

Estimation with sixths

Based on the method used by Metallinos et al (1990) the text-faces (and not the pages) in each book were mentally divided into sixths and each illustration coded as occupying 0–1/6, 1/6–2/6, 2/6–3/6, 3/6–4/6, 4/6–5/6, and 5/6–6/6 of the text-face. (It is of course also easy to use a grid, drawn on a transparent foil.) Some pictures may actually be larger than the text-face. Such pictures are coded in the 5/6–6/6 category. The number of pictures within each category was multiplied by the theoretical mean size for each group (that is 8.8%, 25.0%, 41.6%, 58,3%, 75.0%, and 91,5% respectively). The added total picture area was then divided by the total text-face resulting in an "estimated picture area index".

Calculation results

To be able to compare the three methods the differences between the "real picture area index" and the two "estimated picture area indexes" were calculated. As we can see in the table below these differences are small with both methods.

Estimation with quarters resulted in a mean difference of 2.3%, and estimation with sixths resulted in a mean difference of .4%. These results indicate that the method of "Estimation with quarters" is "good enough" for practical work. This method is very quick and easy and far less labour-intensive than the laborious method of exact measurement.

The picture area index (%)

The picture area index	*Book 1*	*Book 2*	*Book 3*
Number of pictures in chapter	16.0	37.0	53.0
Number of pages	21.0	23.0	26.0
The real picture area index	26.9	32.6	26.5
Estimated picture area index, quarters	25.0	29.9	32.2
Difference 1	1.9	2.7	5.7
The real picture area index	26.9	32.6	26.5
Estimated picture area index, sixths	27.0	34.0	30,5
Difference 2	0.1	1.4	4.0

It would be interesting to make a collection of picture area index-data for "typical textbooks" used in different countries. At the same time one should also calculate the "picture index", defined as the average number of pictures for 100 pages (Pettersson, 1990).

Also see the discussion on the verbal and visual area diagram in the section *Text, picture, and background* in the chapter *Information graphics*.

Graphic symbols

Taking up only a very small amount of space, symbols can provide or convey information, equivalent to one or more sentences of text. Eco (1976) suggested that the verbal equivalent of an iconic sign is not a word but a phrase or indeed a whole story. This is, of course, also the case with the large number of Chinese kanji-characters, designating different words or sometimes phrases.

Use of graphic symbols

The use of graphic symbols has a long tradition. Functional, instructive graphic symbols are actually older than words. They are found in every culture however primitive. In specific areas symbols are a supplement to all languages to help create better and faster understanding. Symbols first appeared as paintings or carvings on caves and stone walls as early as 50,000 BC, with the first depiction of humans dating back about 11,000 years (Dewar, 1999). There is also a need for various symbols in modern societies.

Since 1974, the American Institute of Graphic Arts (AIGA) and the United States Department of Transportation (DOT) have collaborated to a symbol system that will help travellers navigate their way through airports, bus and train stations, large international events, and unfamiliar public places. This system, 2013 consisting of 50 symbols, is designed to guide people, regardless of age or culture, to where they are trying to go or what they are trying to reach.

Groups of graphic symbols

I distinguish between two main categories of representations, (I) figurative representations, and (II) non-figurative representations (Pettersson, 2002). Figurative representations include two groups, 1) *visuals* and 2) *graphic symbols*. The group graphic symbols include three subgroups 1) pictorial symbols, 2) abstract symbols, and 3) arbitrary symbols.

Pictorial symbols

Pictorial symbols (or representational symbols) are "image related" and simplified pictures. Pictorial symbols resemble the objects they represent. They can be characterized as silhouettes, shadows, or profiles with no surface detail. A traffic sign with a silhouette of a locomotive, to denote a railroad crossing, is an example of a pictorial symbol. In the design process, some pictorial symbols may be successively simplified into abstract graphic symbols.

Abstract symbols

Abstract graphic symbols can look like the objects they represent but have less detail than pictorial symbols. Good abstract graphic symbols are intuitive and we should be able to understand their meaning.

The modern symbols typically found in airports and in travel guides are intended to convey generalities of the same order of abstractness as words. Their characteristic graphic neutrality is perhaps the most significant aspect of their invention by the Isotype Institute (Neurath, 1936).

In athletic contests, like the Olympic games, abstract graphic symbols are often used to denote the different sports. Good abstract graphic symbols are intuitive and we should be able to understand their meaning.

Arbitrary symbols

Some figurative symbols are arbitrary symbols. They are invented and constructed out of the designer's imagination. Usually arbitrary graphic symbols have no resemblance at all to the objects or the ideas they represent. Many are based only on the use of geometric shapes and colours. Many signposts and some traffic signs are examples of signs with arbitrary symbols. Arbitrary symbols are unambiguous by convention. We agree and decide on their meaning. Just as new terms have to be learned when we begin to study a new topic; we have to learn arbitrary graphic symbols. Every motorist has to pass a test in order to get a driver's licence.

Cochenour, Rezabek and Westhoff (1998) studied the interpretations of 12 arbitrary graphic symbols. In this case, 96 respondents showed a wide disparity in their interpretations, with as many as 51 different categories of meaning for a single symbol. The average number of no-meaning responses was 13.

Visual terms

Quirk, Greenbaum, Leech, and Svartvik (1985) noted that pictograms most reliably can substitute for words in "block language" – single-word captions, headings, and labels – as distinct from sentenced language. Graphic symbols may be intended to convey generalities of the same order of abstractness as verbal terms. In some cases we can see graphic symbols as *visual terms*.

Symbols may be visually more distinctive than text. Their syntax and semantics may be simpler. Image perception is rapid, virtually "instantaneous". Reading and comprehending the equivalent message in words takes much more time, and may fail if it is hard to read the text. So symbols permit rapid

reading and comprehension, and they may require less time and effort for learning. This is important in numerous situations, e.g., in traffic, in industry, and in aviation.

Objectives

There are many reasons to use symbols. Graphical symbols can be used effectively in manuals and on screens to help readers to quickly recognize and identify a specific message. Symbols can be used to create an overview and provide a holistic perspective. This property is utilized in maps and informative signs as well as in catalogues and project reports.

Graphic symbols may be used to identify information, illustrate spatial and geographic position, illustrate size relationships, navigate in databases, provide a holistic perspective, recognize information, and represent an organization, a service, or a product. Graphic symbols may supply information and supply instructions. Graphic symbols have evolved to the point of universal acceptance in such areas as music, mathematics, and in many branches of science.

Pettersson (1985, 1987) concluded that perceived image content often is different from intended image content. Even simple pictures and also symbols may cause many different associations. A given set of basic picture elements and symbols can be combined to form completely different images. Moriarty and Sayre (1993) studied intended and perceived advertising meanings. They also found a high level of disagreement between intended and perceived messages. More than half of the responses were different from those intended, and expected by the message creators. Symbols must be meaningful, legible, learnable, memorable and used consistently (Dewar, 1999).

Interpretation of meaning

The meaning of a symbol is seldom easy to guess (Pettersson, 1989, 1993). Griffin and Gibbs (1993) and Olmstead (1999) found that graphic symbols were interpreted in many different ways. Sometimes only a few persons will understand the intended meaning of a symbol. Thus, the sender will always have to supply explanations for the symbols used in any specific situation.

Symbols in business presentations

Griffin et al. (1994) studied how international business people interpreted and understood commonly used clip art symbols. The symbols were taken from a Harward Graphics software package for business presentations. Based on 4.530 opinions expressed by 302 subjects in Japan, Sweden, Tanzania and USA, regarding 15 of the symbols in the software package, Griffin et al. made the following two conclusions:

- There are many ways to interpret symbols. Very few people share the same understanding of any given symbol.
- There are strong cultural differences in interpreting the meanings of symbols.

Four *verbal symbols* resulted in many interesting observations. Symbols in this category were either understood or not understood at all. There were 90% appropriate answers from the subjects in the USA and 80% from the subjects in Sweden. For Tanzania and Japan, the corresponding numbers were 27% and 29% respectively. The rank ordering of the mean numbers of appropriate answers for seven pictorial symbols was 80% for USA, 69% for Sweden, 60% for Tanzania, and 48% for Japan.

The remaining four *abstract symbols* were the most difficult symbols for all audiences to comprehend. Here definitions differed strongly by symbol and by country. In this study, it was common for the subjects to give several meanings for each symbol. For example, the 81 Swedish subjects gave 20 different interpretations of a symbol with the shape of a star.

Telecom symbols

Nilsson and Lindqvist (1995) examined a random selection of telecom publications. They browsed about 1,000 pages. From this material they selected 100 pictures and registered about 350 symbols. This study concluded that:

- A certain meaning is explained with several different symbols.
- A certain symbol has several different meanings.

Within the Swedish R&D-company Ellemtel, several people designed their own graphic symbols, which they used in various combinations in schematic pictures in their own documents. In a sample of documents no less than 29 different "telephone-pictures" were used. Some of the telephone-pictures were well-drawn schematic pictures, some were pictorial symbols, and some were abstract symbols. All these symbols were replaced by two graphic abstract symbols for telephones, passive, and active to be used in schematic pictures.

Sepulchral symbols

Cochenour and Rezabek (1997) studied the interpretations of 21 sepulchral symbols. Respondents showed a wide disparity regarding their ability to understand the meanings of the symbols. Nineteen percent of the responses indicated that no meaning at

all was conveyed, while 31% were considered as "understanding of the intended meaning".

It was concluded that symbols carry a variety of meanings for different people and when used alone as a means of visual communication cannot be expected to always convey a simple and direct meaning.

International communication

At the end of his book on writing for science and technology, Kirkman (1992) noted the possibility of using symbols in international communication (p. 155): "Perhaps, since use of words causes so much difficulty in international communication, we should abandon words wherever possible, and use icons instead."

Kirkman used the term "icon" in the same meaning as I use the term "symbol" here. Symbols may very well become more and more common in international communication. Kirkman commented (p. 156): "I have no doubt that we shall gradually have to include more and more icons in our presentations of information, especially in our onscreen presentations."

Many pictograms are culturally biased (Mangan, 1978) and thus arbitrary to those from other cultures. For example, when using a guidebook with symbols, we often have to look them up in a key in much the same way as we look up unfamiliar words in a dictionary. Their iconic origins may only become apparent after we are aware of their intended meaning (Waller, 1987). Baron (1981) reported that iconicity is a surprisingly unimportant factor in the learning of sign languages for the deaf, autistic, or mentally retarded.

Warnings

Many symbols are used for warnings. Wogalter (1999, p. 94) concluded that warnings should contain certain elements:

- A signal word such as “Danger” and “Caution” that enables people to recognize that the message is a warning, that a hazard is present, as well as providing information on the hazard level (with “Danger” signalling more serious and probable injury than “Caution”);
- A description of the hazard, e.g. in the case of a no diving sign, a statement such as “Shallow water” provides information about the specific danger involved;
- A description of the consequences that could occur if the person fails to obey the warning’s directions, e.g. “You can be permanently paralysed”;
- The directions or instructions, i.e., the specific actions that should or should not be done, e.g. “No diving”.

Traffic signs

Traffic signs and signposts are various devices with symbols, placed along, beside, or above a highway, roadway, pathway, or any other route in order to guide and help with directions, regulate the traffic and warn for dangers. The symbols may also be painted on the streets, and sometimes on the walls of houses. The traffic may include many kinds of motor vehicles, bicycles, pedestrians, equestrians, and other travellers.

Road signs and signposts may be divided into four main groups: 1) warning signs, 2) mandatory signs, 3) prohibitory signs, 4) information signs, and the STOP sign. Today road signs are manufactured in different materials such as aluminium, galvanized sheet iron, and flat or canned panel. The

symbols on the signs may be painted, printed or duplicated in other ways. The motifs are designed in different ways even if they carry the same or similar messages.

In order to be effective a warning must reach the intended audience and make them adopt the desired behaviour. Several steps are needed here. Initially any warning, and any symbol, must attract and capture the attention of the intended audience, the persons who need the information. The message must be legible at the appropriate distance, and must often be legible when seen for a short period of time under bad lighting conditions. A driver on a highway may only have a second or two to read a signpost. Then the message in the warning must be mentally processed and understood correctly by the intended audience. The action to be taken should be immediately obvious. Furthermore the message in the warning must be able to motivate the audience to comply with the desired behaviour.

Wogalter pointed out that warnings should have properties that allow them to be seen in degraded conditions such as low illumination, smoke or fog. In addition warnings should be adequately lit by direct light or by backlighting and/or have good reflectance so that they are visible under reduced-light conditions.

The United States Department of Transportation (2002) says that roadway signs in the United States increasingly use symbols rather than words to convey their messages. Thus it is important that these symbols maintain a consistency in colour, layout, position, shape, space, and text.

Project "crossing road signs"

In communication senders want to communicate messages or make information sets available to receivers or rather interpret-

ers. In the case of warning for and information about pedestrian crossing road signs the city authorities are the senders. The *warning sign* for a pedestrian crossing convey a simple, but important message to the *motorists*: “Look out and slow down, there is a pedestrian crossing ahead.”

The warning sign is usually triangular, sometimes with soft corners. The actual symbol consists of a wide line forming a red triangle on a light background. Graphical elements, dots, lines, and areas, are combined to form a simple figurative and abstract representation of a person. Some graphical elements may also represent street lines showing a pedestrian crossing.

A warning sign and an information sign (from Germany and Lithuania). These symbols are classified as abstract.

The *information sign* is usually rectangular, sometimes with soft corners. This particular sign is from Lithuania. The triangle is white. The four graphical elements representing a person and the three graphical elements representing street lines are black. The person appears to be running to the right. This symbol is classified as abstract. In Lithuania there are also signs with the person moving to the left. Graphical elements, dots, lines, and areas, are combined to form a simple figurative representation of a person. Some graphical elements may also represent street lines showing a pedestrian crossing

An information sign about a pedestrian crossing convey slightly different messages for two different groups of receivers. The message to the *motorists* and other road-users is: “Look out

and slow down, pedestrians are told to cross the street here." The message to the *pedestrians* is: "This is the place where you should cross the street."

In several locations this information sign is replaced by traffic lights. Traffic lights convey more distinct and "sharp" instructions to motorists as well as to pedestrians than pedestrian crossing warning and information road signs. Here the instructions may be expressed as: Drive now!, Do not drive!, Walk now!, and Do not walk! respectively. The design of traffic lights may vary substantially. However, design of traffic lights is not included in this study, and not the sign explaining that children may be playing alongside the road as well as on the road.

I have studied 52 different pedestrian warning and information crossing road signs from 32 countries (Argentina, Australia, Austria, Belgium, Chile, China, Cyprus, Czech Republic, Estonia, France, Germany, Ghana, Iceland, India, Ireland, Italy, Jordan, Lithuania, Luxembourg, Malta, Mexico, Monaco, Norway, Peru, Poland, Portugal, South Africa, Spain, Sweden, Switzerland, Turkey, and USA). Some of these road signs were brought to Stockholm for a public exhibition in 1998. The graphic designer Anders Körling put together the exhibition *The World Walks in Stockholm* as an event during *Stockholm '98, Stockholm – Cultural City of Europe 1998*.

I have taken photographs of the crossing road signs at this exhibition. I have also taken photographs during my travels in various countries. In addition, people have provided me with photographs of crossing road signs in a few cases. The pictures presented in this report have been scanned and retouched using Adobe Photoshop™. The design of pedestrian warning and information crossing road signs wary with respect to shape, colours, size, and number of graphic elements in the symbols.

Pedestrian warning and information crossing road signs wary with respect to their shape, colours, size, and the design of the figurative representations. Differences in material and in the construction of the signs and signposts are not discussed here.

Shape

Pedestrian crossing warning and information road signs vary in shape in different parts of the world. In Europe warning signs are triangular, and information signs are rectangular. In other parts of the world the information sign may be rhombic or circular. On the signs from Argentina and Australia (below) the pictorial symbols are black on yellow backgrounds without indications of street lines.

The rhombic sign is from Argentina. The circular sign is from Australia.
These symbols are classified as pictorial.

Colours

Pedestrian crossing warning and information road signs vary in colour in different parts of the world. In Europe warning signs usually have white, black and red colours. In Sweden warning signs are yellow, red and black. In many countries the information signs are blue, white and black. In some countries the colours are white and blue; white, yellow and black; or yellow and black. The figurative representations are usually black, on a white, blue or yellow ground.

Size

Pedestrian crossing warning and information road signs vary in size in accordance with different situations. In this sample the smallest sign is 40 cm (Cyprus) and the largest is 102 cm (Argentina). Most signs are between 55 and 75 cm. Thus the impression of the pictures printed here corresponds to the impression from viewing the real signs on a distance of five to seven metres.

Mr. Walker

The symbol on pedestrian crossing warning and information road signs varies to a large extent. Almost all are different with respect to their design. The person in the symbol is always "Mr. Walker". Nowhere is the figure representing a woman (Jofs, 1998). (However, in 2010 Sweden introduced Mrs. Walker.) In this study Mr. Walker is an abstract graphic symbol (27), or a pictorial graphic symbol (25).

As would be expected, there are no arbitrary graphic symbols in this sample of symbols. In one case (Australia) the sign only shows the lower parts of the legs and the feet. For some reason most figures on the signs (44) are crossing the street to the left. The remaining figures (8) cross in the other direction, to the right. Estonia and Lithuania have both versions of signs.

Most figures (42) seem to be walking across the street over to the other side, but some (9) appear to be running. In one case (Mexico) the figure appears to be standing and waiting for a possibility to cross the street. In two other symbols from Mexico the person appears to be walking. Some symbols are very clear and distinct; others are "blurred" by a large number of graphical elements.

The person is an abstract graphic symbol on the left warning sign from Malta, and a pictorial graphic symbol on the middle sign from Switzerland. In both cases the person is apparently walking to the left. The number of graphical elements varies to a large degree. On the sign to the right, from France, there are a total of 21 graphical elements. However, Mr. Walker consists of only one graphical element.

The numbers of graphical elements that are used to build the Mr. Walker figure vary (1–4), as the total number of graphical elements (2–21) in the symbols. The painted street lines form a graphic world of their own. The number varies to a large degree. In some cases the street lines may actually confuse people. Some signs have no street lines. I don't know to what extent the number of street lines varies in different countries. In Sweden there are four graphical elements on the symbols representing the lines painted on the streets. The number of painted lines may vary.

Message and symbol

There are probably pedestrian crossing road signs in most cities, at least where there are cars. In accordance with international conventions and national legislations on road signs and signals, most road signs have a similar design. For example, the official manual for signing in the United States is the Manual of Uniform Traffic Control Devices. Warning signs are triangular.

Information or instructional signs are rectangular or rhombic. Prohibitory signs and mandatory signs are round, but with different colours. However, the symbols on the signs may differ in several respects. Every country has its own version, or rather versions, because some road signs differ between regions. Some of these signs may be old versions, waiting to be replaced.

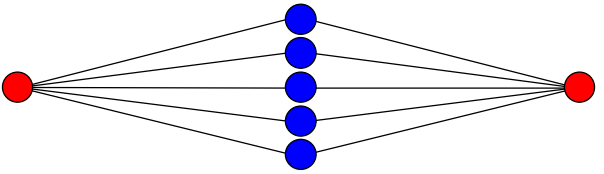
There are several requirements that must be fulfilled for road signs to be effective communicators of information. The designs of the symbols, as well as the contexts in which the signs appear are important factors for our perception of the message. The abstract or pictorial graphic symbol on the sign must have good legibility and be easy to read from a distance. Obviously pedestrian crossing road signs must be placed in such a way that the motorists as well as the pedestrians can see them. Signs should be placed as necessary for safety and proper regulation of traffic. However, the use of too many signs within a given location severely reduces the effectiveness of each individual sign at that specific location. There is a distinct risk that we will not see, or pay attention to, some of the signs.

It is quite obvious that traffic symbols are designed in many different ways, even when they convey the same or similar information to people who see them. This may not seem to be an important issue, since people have to learn the meaning of all-important symbols within their own society. However, with respect to the fact that international travel seems to increase all the time, and more people visit different countries, it would probably be an advantage to have a “world standard” for a set of basic symbols, including traffic signs. This would probably reduce the number of misunderstandings and traffic accidents.

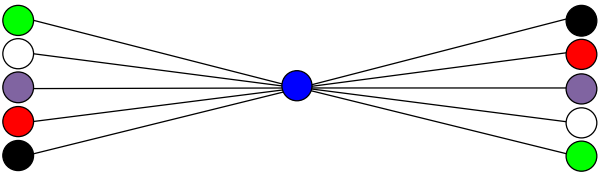
The above study supports the assumptions noted in the introduction. We may conclude that:

1. A specific message may be communicated to the receiver/s or interpreter/s with several different symbols.
2. A specific symbol may be used to communicate several different messages.
3. People have to learn the meaning of all-important symbols within their own society.

The first two points may also be visually represented in the following two schematic pictures:



A specific message (left red circle) may be communicated to the receiver/s or interpreter/s (right red circle) with several different symbols (middle blue circles) as long as people learn the intended meanings of the symbols.



A specific symbol (middle blue circle) may be used to communicate several different messages (left circles) to the receiver/s (right circles) as long as people learn the intended meanings of the symbol.

With respect to the design and the use of symbols it may further be concluded that:

1. Receivers may interpret symbols in many ways.
   - Few people share the same understanding of any given symbol.
   - People can usually not guess the meaning of symbols.
   - There are strong cultural differences in interpreting the meanings of symbols.
2. The senders will always have to supply explanations for symbols.
   - Symbols should be used in a consistent way.
   - A symbol must always have the same meaning within a specified context.
3. A good symbol is designed so it can be used in many different situations and in many contexts. A good symbol:
   - Is simple
   - Is clear
   - Has optimal size
   - Has good contrast in form, dimension, and colour
4. Graphical symbols may be intended to convey generalities of the same order of abstractness as verbal terms. In some cases we can see graphical symbols as visual terms. Graphical symbols may be used to:

   - Create an overview
   - Identify information
   - Illustrate position
   - Illustrate size relationships
   - Navigate in databases
   - Provide a holistic perspective
   - Recognize information
   - Represent an organization, a service, or a product
   - Supply information or instructions

Design of graphic symbols

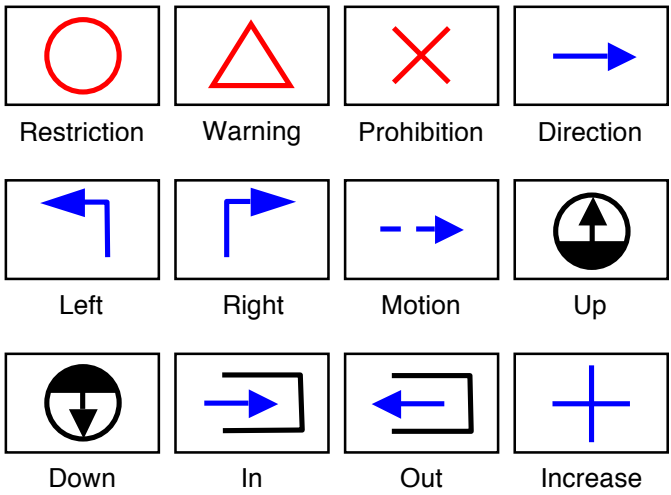
With the increase in international travel and trade, there is a growing need to communicate with people who do not understand the language of the country they are in. The use of symbols is one of the most common ways to deal with this situation. However, there may also be some disadvantages with symbols. Symbols may be less efficient than text in conveying abstract, as well as detailed information.

Dewar (1999) pointed out that the specific criteria for individual symbols or sets of symbols depend on their application. Legibility distance is essential in the case of traffic signs and many building signs, but not for symbols on maps or consumer products. There is a need to have as much uniformity as possible across different information systems.

When designers in different countries are working on similar problems they may create different solutions and different designs. In each case, they may have clear intentions and objectives with his or her information sets. However, it is always up to the interpreter/s to conceive or misconceive information, to use or not use it, to use or misuse it. It is reasonable to assume that 1) a specific message may be communicated to the receiver/s or interpreter/s with several different symbols. It is also reasonable to assume that 2) a specific symbol may be used to communicate several different messages. If the assumptions above are correct it would indicate that 3) we will normally have to learn the intended meaning of symbols.

Symbols are often composed of simple graphical elements, such as lines, circles, ovals, squares, rectangles, triangles, or combinations thereof. Distinctively shaped letters are often utilized in modern symbols. Regular, simple, geometrical figures are identified more quickly than complex ones. Keates

(1982) noted that discriminatory responses to map symbols depend on contrast in form, dimension, and colour. The problem of discrimination is generally more critical in monochrome maps, in which only contrasts in form and dimensions are possible for lines and small symbols.



Here are some basic symbols that appear and reappear in many different situations in various countries throughout the world.

The graphic symbol should be simple and clear with a distinct contrast to the background. A clear and stable figure to ground articulation is essential (Dewar, 1999; Easterby, 1970). The figure ("foreground") should be stable, i.e. spontaneously organised as one unit. This is achieved by close boundaries, appropriate line thickness and any other graphical means that help the visual system to organise the figure as one unit. It is most appropriate to use silhouette (side) views of certain components such as vehicles (Dewar, 1999). The graphic symbol

should be as symmetrical as possible. It should appear in an optimal size.

A good symbol is designed so it can be used in many different situations and in many contexts. For example, the McDonald's M or "golden arch" is designed to work in every conceivable size, from a few millimetres high in a brochure to more than six feet high in outdoor signs. It is often an advantage that a symbol is iconic, that is, that it looks like the real thing it represents. Then it may be intuitive to the users. In technical and scientific systems and documentation, hardware may be symbolised by squares and rectangles or the like. Softer forms, such as circles or ovals, may represent software.

Graphic symbols often make use of bright colours to intensify their meaning – in fact in some instances a change of colour creates a diametric change of meaning. Common hues are pure yellow, red, blue, green, white and black, or combinations of the same. Colour creates instant impact. It becomes a vital part of the first impression created. Industry employs colour coding in many areas. The countless wires in a complex cable are instantly traced by their hue; the colours of knobs and buttons on vehicles and machinery signify what they control (Dreyfuss, 1972).

However, since many people are colour-blind colour can only be used to code the information redundantly. Colour may be combined with shape or position. Complementary colours contrast and provide a warm – cool effect. Colours may have many different meanings; some common meanings and their attention getting values are listed in the table on next page.

Colours and their attention getting values.

Hue	*Meaning*	*Attention*
Red	Alarm, danger, financial loss, fire, heat, stop, unsafe, warning	Good
Orange	Warning	Good
Yellow	Caution, danger, hazard, oil, slow, warning	Good
Green	Go, normal state, safe, satisfactory	Poor
Light blue	Advisory, aerated water, cool	Bad
Dark blue	Advising, untreated water	Poor
Magenta	Alarm state	Good
White	Advisory, stem	Poor
Black	Financial gain	Poor

Warnings should have high contrast relative to the background (Barlow & Wogalter, 1991; Sanders & McGormick, 1993). They should have large, legible bold-faced alphanumeric characters (Wogalter, 1999). Legibility of symbols can be enhanced with the application of a few simple guidelines:

- Use realistic figures rather than abstract forms.
- Make important figures and characters large.
- Eliminate unnecessary elements.
- Use solid figures, not outline figures.
- Maximize separation between features in symbols.
- Maximize the luminance between a symbol and its background.
- Maximize the colour contrast between a symbol and its background.

According to Keates (1982), the use of colour on maps introduces a large number of variables that can enhance contrast, and therefore extend the number of perceptual differences that can be employed in discrimination. The effect is to aid legibility, and therefore to increase the total range of information which the map can present. Shape and colour components are often used for designating a link or relationship between groups of messages. The recognition of geographical features is much enhanced when areas are differentiated by hue. At the same time, complex colour arrangements may raise problems in discrimination, so that although multi-colour maps enlarge the graphic possibilities, they also increase the probability of errors in the judgment of discrimination.

According to Keates (1982), the most common case of quantitative judgment on maps occurs in the use of proportional symbols, that is, point or line symbols constructed to represent specific quantities. Cochenour, Lee and Wilkins (1995) provided the following design guidelines for functional image maps on the World Wide Web (p. 172):

- Use simple graphics.
- Use smaller rather than larger image sizes.
- Clearly define hot spots.
- Use unified rather than scattered groupings.
- Choose icons to accurately represent information.
- Design image maps to model the structure of information.
- Use a minimal number of layers.
- Limit the number of choices.
- Include site-specific help.

Before beginning to design new symbols, it is a good idea to consider employing already existing symbols. Standardisation

bodies like ISO (International Standards Organisation) and IEC (Commissioin Electrotechnique Internationale) officially recommend many symbols. There are a large number of existing symbols for different areas. Symbols are employed in different media. They are static and immutable in graphical media and may be more changeable in computer-based media. As noted in the introduction designers in different countries may be working on similar problems, and they will often create different designs. Most, if not all, countries have traffic signs. In order to study similarities and differences in the design of a highly restricted message I have analyzed pedestrian warning and information signs. This study is presented in the following section.

Information graphics

A particular message is sometimes presented through the purposeful integration of text, pictures, and graphic design into a clearly delineated and structured area, i.e., a functioning whole. (However, nowadays this term is used in a broader sense.) The result of this work is a product called information graphics, infographics, or just “graphics”. Infographics are widely used in newspapers and newscasts (Lamb et al., 2014; Smiciklas, 2012).

Examples of confusing, misleading, and ineffective graphics are everywhere. The three essential elements of good information graphics are rich content, inviting visualizations, and sophisticated execution (Wong, 2010, p. 14). *Rich content* brings meaning to the graphic. *Inviting visualizations* interprets the content and highlights the essence of the information for the reader. *Sophisticated execution* brings the content and the graphics to life.

Graphics

Information graphics are informative and may be entertaining. They aid communication, enabling better understanding and comprehension. Information graphics are attention-getters when they appear on a page in a newspaper. They may improve readability and increase retention. In the past, information graphics were produced by hand, a tedious work process. Today most information graphics are produced with computers. Ideas can be tested in less time and good solutions may be found. In the case of newspapers, information graphics can be the key to attract new readers and to hold on to old readers.

Most visualizations originating from quantitative data include axes or scales, coordinate systems, or glyphs that use spe-

cific data values as an input (Schroeder & Martin, 2005; Tversky, 2011). The appearance of a glyph corresponds directly to data as a result of the principled mapping of data variables to visual features such as position, size, shape, and colour (Heer, Bostock, & Ogievetsky, 2010, p. 67).

Information graphics provide the reader with a rapid and easily grasped overall view of a message and are therefore highly suitable as an introduction to and summary of a subject. However, conventionally illustrated text is better for analysis, discussion, and study of details. So information in graphical media can utilize text, pictures, information graphics, and graphical design in conveying its message. We should note that the word "graphics" can be used for completely different concepts:

1. One or more art forms in which copies can be made on paper or the same original.
2. Activity involving the printing of the written word.
3. Integrated presentation of text, pictures, and graphical design, in, e.g., the daily press, information graphics.
4. The technique of presenting data in the form of figures on a video display screen.

Wainer (2009, p. 31) observed: "graphical representation has been shown repeatedly over the past two hundred years to be perhaps the best way to communicate complex technical information to an intelligent, lay audience."

Modern information graphics has its origin in the tradition of making posters and advertisements. These visual forms of communication spring from a past in older times, when pictures and texts were combined into information on circus and theatre posters, and on signs on inns. The oldest posters were created at

the end of the 14th century, when printing on paper started in Europe. Leaflets with text and simple pictures were used by booksellers and travelling theatre companies and for political agitation. The posters' roots are traced back to antique Athens, where the City Fathers put up notices with regulations.

On the 15 September 1982, a new type of daily paper was published in the USA. From a central editorial office in Arlington, Virginia, the produced pages were sent via a satellite to printing houses in eleven cities, where USA TODAY was printed. As early as after one year, the daily edition was more than one million copies. Today, the paper is widely spread in the USA and in several other countries. The paper is as fragmented as the news on television, and is often being criticized for being too superficial.

USA TODAY is the paper of the television generation. It is divided into four separate sections: news, money, sports, and life. Each section has its own cover story and a large number of easily read mini-notices. The headings are effective, and the text is often heavily edited. The notice has replaced the article. There are many photographs, drawings, diagrams, and tables in the paper. USA TODAY introduced modern information graphics, and has been imitated all over the world. It is the most copied paper in modern times.

Baer and Vaccara (2010) provided a range of interesting case studies, from print projects to interactive and environmental information systems.

According to Lankow (2012) a test of the efficacy of an infographic is based on the first-century architect, author, and engineer Marcus Vitruvius Pollios principles of good design. We need to measure the *utility*, the *soundness*, and the *beauty* of infographics. *Utility* refers to whether the infographic meets the

designer's objectives or not. *Soundness* refers to whether the information presented in the infographic is complete, correct, and valuable to the viewer. *Beauty* refers to whether or not the design of the infographic is appealing and appropriate.

Objectives

According to Malamed (2011) the goal with information graphics is to re-present data in such a way that the intended audience is able to quickly grasp the content primarily by sight. Infographics are a popular visual approach to deliver abstract, complex, and dense messages in small areas (Lamb et al., 2014).

In order to facilitate an audience's engagement any infographic must exhibit appearance and explanation (Stone & Hall, 1997). Visual appeal attracts viewers' attention. The explanatory power of the infographic makes complex subject matter apprehensible and intelligible.

Information graphics can be classified according to different criteria, such as objectives, medium, size, and time for production (Pettersson, 1993). One specific graphic may very well belong to several of these groups. We can produce information graphics in order to achieve several different objectives.

Content graphics or everyday graphics are used for information about the content in packages, e.g., with food. Decorative and artistic graphics can also be found in both newspapers and television. Even though informative graphics can be both decorative and aesthetically attractive, the informative function always predominates. So purely decorative and artistic graphics are not information graphics. Explanatory graphics depict the ways things were, are, or will be, for example, the weather. These graphics range from simple drawings to complex combinations of drawings, maps, and photographs.

Expo graphics are used at exhibitions and trade fairs. A subject matter is presented using verbal and visual technique and the real objects. The graphical information may aid understanding of how the real objects can be used. Instruction graphics are used for instructions, e.g., in instructional manuals. Instruction graphics may deal with how to use, e.g., a machine or how to prepare, e.g., a meal step by step. Locating graphics are used to give the physical location of an event or of an object. Based on one or more maps, movements of an object can be explained. Maps are often also included in other kinds of graphics.

News graphics are used to convey all kinds of news that are fit to see rather than to read as a printed story. News graphics are found in, e.g., newspapers and some magazines, and also on television. Presentation graphics depict facts and are often used for different types of statistical tabulations. A graph or chart can be integrated into a symbolic image to heighten impact and identify the subject. Presentation graphics are often used for "business presentations". They are often called business graphics. Signal graphics are small-scale graphics used to add impact and visual relief to a text.

We encounter information graphics in many different media. In graphical media (books in particular), information graphics are often referred to as lexivision or lexi-visual information. In the corresponding manner, lexigraphy is a special version of infography for lexi-visual presentation of text, pictures, and information graphics in graphical media and computer media. Graphics are called reference book graphics in reference books and dictionary graphics in dictionaries and encyclopaedias.

There are a number of different types of information graphics, and we will probably see more types in the future (Lankow et al., 2012; Marcel, 2014).

Time for production

The American national daily newspaper USA TODAY was a pioneer in the field of news graphics and has acquired imitators in many different countries. “News graphics” is a summarizing designation for several somewhat differing forms of information graphics. Due to available time for production, news graphics can be divided into several groups.

Business graphics are found in computer programs and newspapers. Business graphics is a general designation for information graphics that present economic and statistical data, for example: “the production of crude oil over the past five years”.

Daily graphics is generally produced against tight deadlines. News must be published in the next edition or in the next TV news slot.

Feature graphics is a general designation for information graphics that describe more timeless subjects, such as popular science. Here, the producer may have several weeks or even months to create the copy and acquire the photographs.

Planned graphics is the designation for information graphics that the editors of news graphics have a few days to produce. This provides more opportunities for checking facts and more carefully thought-out execution.

Weather graphics are information graphics describing what the weather has been like and how it is likely to be according to available forecasts. The colourful weather graphics in

USA TODAY have inspired a large number of dailies to introduce information graphics.

George-Palilonis and Spillman (2013) asked 53 editors about their attitudes and practices about use of infographics. Most editors supported production of infographics. However, the availability of time and in-house expertise, as well as cost effectiveness influenced their decisions.

Everyday graphics

Today, we can study some of the classical posters from last century in art books and in museums, such as the Musée des Arts Décoratifs in Paris. It is possible – and even plausible – that some of the information graphics of today will find their way into art and design museums at the turn of this century or at the beginning of the 21st Century. (See *Information Design 6 – Predecessors & Pioneers*.)

In several respects, everyday graphics differs from other types of information graphics. Contrary to the producer of news graphics, but in conformity with the producer of posters, the producer of everyday graphics often has time enough to plan and design the messages in an optimal way. However, the space is often very limited for everyday graphics. The amount of the article and the size of the product decide the space available for the design of the verbal and visual message. In practice, however, there is the same space for about the same amount of information on a small label as on a normal-sized poster. When we read a label of 4x4 cm at normal reading distance (30-40 cm), it corresponds to a poster of 100 x 100 cm when reading it at a distance of 7-10 metres. When it comes to reading posters, the most common way of reading is at a distance.

Just as posters, everyday graphics have short and concentrated messages, expressed in a clear and distinct way. We read everyday graphics close at hand, but the retinal picture is about the same as the retinal picture of a poster. Usually, we do not take much interest in a label or a package. The same applies as for posters: it must not take too much time to perceive the message in everyday graphics. Just one glance should be enough to perceive the contents of a package. Does the bag contain sugar, salt, or pepper? Is there raspberry jam or strawberry jam in the jar? Is the content poisonous, or harmful for us in any other way? In several respects almost the same conditions apply when taking in information printed on a poster and on a label or a lid.

When it comes to small packages, the message still has to be designed in order to fit in all the necessary information. Sometimes, there is a national law on how to describe the contents in detail. For some products, there may also exist different types of instruction, enclosed inside the package. As producers of posters, the producers of everyday graphics are usually totally anonymous to the consumers. In other forms of information graphics, however, the names of the originators are often mentioned, and thus known. Everyday graphics may have different purposes. It may be used to instruct, to inform, and to tempt a presumptive customer to buy the product in question.

Instructing

Sometimes, schematic pictures are used to show how something is to be performed in several steps, in a practical, simple, quick, and safe way. One example is how to open a vacuum package with cheese, and another example is how to put together several separate parts in a box into a chair or a table. Symbols are often used. An arrow, for example, may be used to show where to

open a package and to explain in which order and in which way to join different parts.

Informing

Everyday graphics informs on the contents of the package, and the characteristics of the article or product. When it comes to provisions, for example, there is a legislation in some countries that sanctions that some types of data must be on the package. This may be information on the contents of the product, day of manufacture, keeping qualities, producer, and place of manufacture. Also trade agreements and practice within different trades may demand that a certain kind of information – for example, the price of a certain package and the price per kilogram – is presented to the customer/user.

Often, a large and lifelike colour *picture* – a photograph or a realistic drawing – gives the reader direct information or an association on the type of contents in the package. The picture is often reinforced with a *heading* in a large size of type and a clear typeface, often in upper-case letters. There is often a short *text* with detailed information describing the characteristics of the article or product.

The *declaration of contents* may be presented as a compact table or a short text. These texts are often set in a small size of type and printed in a colour with little contrast to the background. It always takes much more time to read the text than to read the picture.

Two examples of everyday graphics printed directly on the lids on individual portions of strawberry jam (life-size). The products are from Denmark (left) and Germany (right).

A *graphic symbol*, such as an arrow, will often show where to get hold of the lid and the direction where to pull, in order to open the package. Often a text and a *logotype* show the *name of the company* that produced the jam. The *address* to the company may be small. There may also be information about the *weight* of the content as well as an *identification code*. Figures written with an ink-jet printer show when the jam was packaged and/or a "best-before date."

Everyday graphics with clear pictures may also work internationally, with people that do not know the language in question. Here, the context is very important. The pictures of oranges, strawberries, raspberries, or peaches on individual portions of jam serve as a good guidance of the people who queue at the hotel's breakfast buffet. On several occasions, I have wit-

nessed how people after a quick glance on different packages make their choices. Obviously, just a few eye fixations on a package are enough to tell the contents.

An example of everyday graphics printed directly on the lid on two individual portions from a company in the USA, with strawberry jam and orange marmalade (life-size).

Tempting to buy

Often, the purpose of everyday graphics is to tempt consumers to buy a certain product in competition with other, more or less similar and equally good, products. Regarding everyday graphics, the "sender" often has the possibility to turn to experts for help to design the message. Experienced marketing people and publicity expert's work closely together to produce verbal and visual messages that function well. The text, pictures, and graphical design of everyday graphics are, therefore, given the final design with great care and consideration.

Everyday graphics may be both aesthetically attractive and decorative. There are also examples of everyday graphics that

are not successful. A label or package are often a part of a series: a part of a carefully prepared “whole”. Products from one company may be kept together with the help of a common logotype or symbol, and with similar graphical design for the choice of typeface and size of type, the placing of texts, and the use of pictures, colours, and decorative patterns. The intention is that a specific graphical profile will make it easier for the receiver/customer/reader to quickly and easily find articles and products from the same supplier.

Tempting to buy? Here is an example of an elegant and free and easy design from France (left), and an example of a less successful design from Belgium (right).

The illustration above contains a life-size example of an elegant and free and easy design of a lid on an individual portion of strawberry jam from a French company. The semicircular text contains information in several languages on the contents. The three strawberries are printed in colours that look “warmed by the sun” and naturally yellow-orange-red. There is

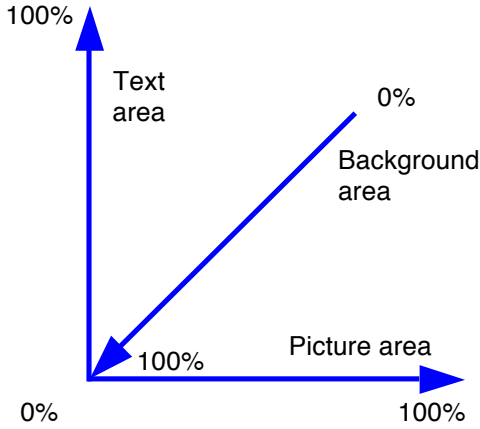
no doubt about the contents or about the trademark. Compare with the life-size example of a less successful design of a lid on an individual portion of strawberry jam, from a Belgian company. Here the message “strawberry jam” is clear, but the berries do not look appetizing enough. The colours are not successful and the trademark is very dominating.

Text, pictures, and background

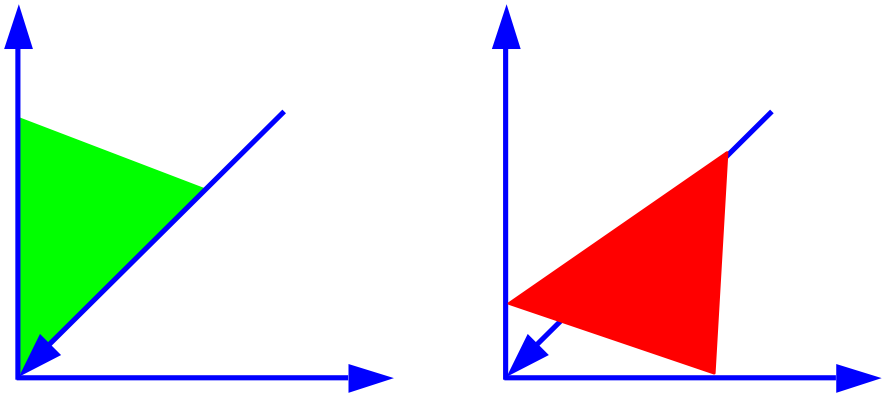
Within a given area – such as a page in a book, a poster, or a label – the designer may distribute text, picture, and background (margins, space, and patterns and designs without any significant picture elements). A typical page in a telephone directory is almost filled with text. There are no pictures, and the margins are narrow. Here, the text may cover 90 percent of the page. In dictionaries the text covers 75-80 percent, and in specialist books and factual study books the text often covers 50-60 percent of the page. In pure literature and children’s books, the text area is often even smaller than that. When a picture covers the entire page, there is no space for text or margins. The third extreme is an empty page.

In order to easily compare the relationship between text area, picture area, and background area in different graphical verbal and visual messages, I have developed a “verbal and visual area diagram”. This diagram has three axes: text area, picture area, and background area. The three axes are graded from zero to 100 percent. The text and picture axis have a common starting-point, and there is a right angel (90 degrees) between them. The background axis is situated at a 45-degree angel to both the other axis, and it is graded from the outside towards the starting point of the other axis. Consequently, where

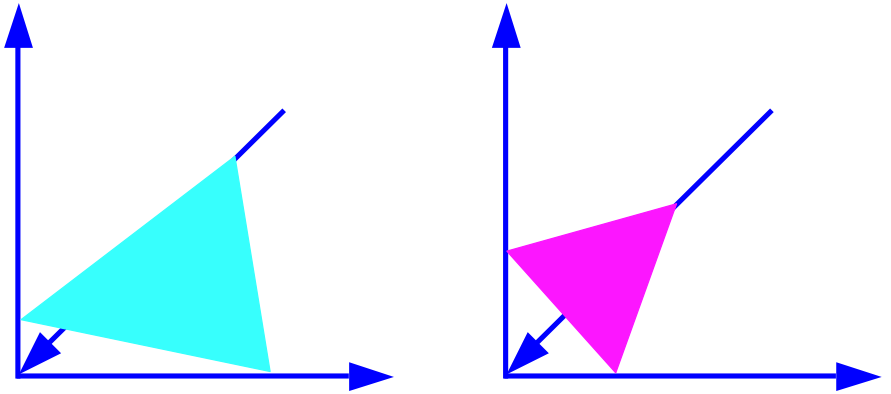
the text and picture areas are zero, 100 percent is background/emptiness.



This is the structure for the verbal and visual area diagram. The three axes are graded from zero to 100 percent.



Visual area diagrams for a fiction book without illustrations (green), and an illustrated book for children (red) may look like these two diagrams.



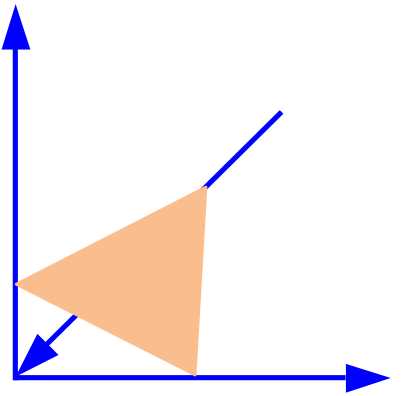
Here are the verbal and visual area diagrams on the mean values of four posters to the left (picture area 68%, text area 15%, background area 17%), and on the mean values of fourteen lids on jam packages to the right (picture area 30%, text area 33%, background area 37%).

The areas for text, picture, and background have been calculated by putting a transparency with a grid over enlarged copies (300 percent) of the everyday graphics, and over reduced copies of some posters. By counting the number of squares for each category, the percentage distribution of text area, picture area, and background area is easily calculated. When text is printed on a picture, the area is equally divided between the two categories. Text logotypes are regarded as text. Symbols are regarded as pictures. Depending on the shape and size of the lids, the number of squares varied between 180 and 270. For the posters, the number of squares varied between 345 and 450. Consequently, a single square always represents less than a percent of the area – often less than half a percent.

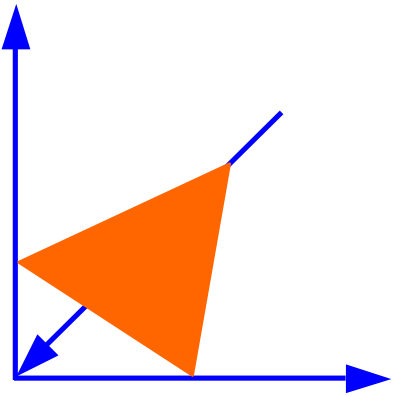
In the artful posters exemplifying this chapter, the picture area strongly dominates the areas for both text and background. This is shown in a very clear way in a verbal and visual area diagram. On the lids of the jam packages there is much more balance between the text area, picture area, and background area. Area diagrams on the mean values of the fourteen information graphics products in this analysis show great correspondence with a page in a book containing the same amount of text, pictures, and background.

However, among the information graphics products that have been studied, there are some examples with a similar distribution of the area as on the posters. We may consider today's everyday graphics as a development of the posters from the turn of the last century. In several respects, the two groups have similar functions, and there are similarities in their designs. A reason for differences in the designs between the two groups may be the great difference between the products to be "sold".

Chéret's advertising for aperitif, books, and foodstuff looks more like today's everyday graphics than the posters in this study. Here, the division of the area is very similar to the French package, "Confiture de fraises". Everyday graphics usually have a very good balance between text, picture, and background. It is probably a good idea to employ this balance also in the production of other kinds of information graphics, as well as in the production of learning materials.



Dubonnet Aperitif is a typical poster (116 x 83 cm) designed by Jules Chéret, 1895. To the right is the verbal and visual area diagram for this poster, (text area 25%, picture area 47%, background area 28%).



Here is an everyday graphic printed directly on the lid on an individual portion of jam from France. The verbal and visual area diagram is shown to the right (text area 33%, picture area 47%, background area 20%).

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