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Information Design

Information Design Theories

Rune Pettersson
Institute for infology

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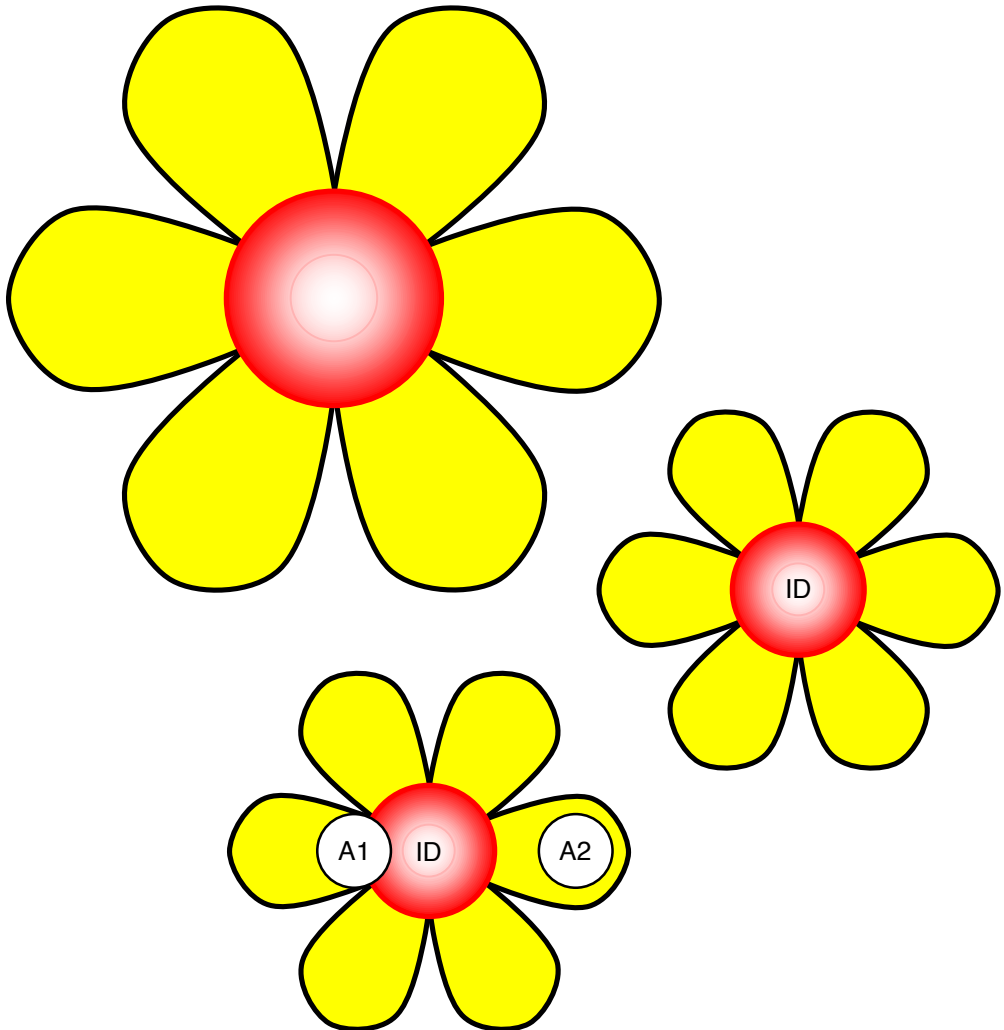
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Information Design Theories



Rune Pettersson * Institute for infology

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ISBN 978-91-85334-34-6

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Tullinge 2016

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Preface

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

Information design has *practical* and *theoretical* components. As an academic discipline we may view *Information Design* (ID) as a “theoretical practice” or as a “practical theory.” Information Design has incorporated facts, influences, methods, practices, principles, processes, strategies, theories, or parts of theories, and tools from a large number of supporting sciences.

In this book I present one *internal information design theory*, and six *external information design theories* with more than hundred facts, hypotheses, and postulates. The internal theory, called *infology theory*, is based on research within the academic discipline Information Design. The six external information design theories are based on research in supporting sciences. These theories are called *Aesthetics theory for ID*, *Facilitating theory for ID*, *Communication theory for ID*, *Providing theory for ID*, *Information theory for ID*, and *Language theory for ID*.

This book is based on my article *Information Design Theories*, published 2014 in *Journal of Visual Literacy*, 33 (1), 1-94.

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Information design

The people of ancient Egypt communicated in a uniquely symbolic manner. The first “travel guides” were produced and sold as early as 4,000 years ago. They were the Egyptian *Books of the Dead* and contained advice and information, in an integrated design with a verbal and visual amalgam of text and pictures on coping with the trip to the Kingdom of Death. The *Books of the Dead may be the first examples ever where text, pictures and graphic design really are integrated in a purposeful way.*

There are number of definitions of *design, information* and *message*. In this book I have used the following definitions:

Design represents two concepts: 1) Identification of a problem and the intellectual effort of an originator, manifesting itself in plans and specifications to solve the problem. 2) The outcomes of each specific design process, such as products, services, processes, and systems.

Information refers to the result of manipulating, organizing and processing data in a way that adds to the knowledge of the person receiving it (Simlinger, 2007, p. 8).

Message refers to information content conveyed from a sender to a receiver in a single context at one occasion. The concept *message design* is used as an umbrella term for the five areas graphic design, information design, instruction design, mass design, and persuasion design. All these design areas deal with the *design of messages*, however with different objectives.

Some descriptions

In my own work I have used the following definition of the general concept *information design* (Pettersson, 1998, p. 27; 2002, p. 19):

In order to satisfy the information needs of the intended receivers, information design comprises analysis, planning, presentation and understanding of a message—its content, language and form. Regardless of the selected medium, a well-designed information material will satisfy aesthetic, economic, ergonomic, as well as subject matter requirements.

Information design does not primarily include areas like advertising, entertainment, fine arts, news, and propaganda. There are many more definitions and descriptions of information design. As an academic discipline information design is written “Information Design” (with I and D in uppercase letters).

Early descriptions

Some early descriptions of information design occurred already in the 1960s. Other groups deal with design of communication, efficiency and effectiveness, interdisciplinary approaches, workability and usability.

An early document is the article *The design of information* by Conrad (1962). Conrad mentioned an accident reported in the newspapers, where a boy froze to death because a search party was not organised—the boy’s relatives knew he was missing, but did not know how to operate the public telephone at the end of their street. Thus they could not call for help.

The *Information Design Journal* started in 1979. According to Rob Waller (IDA, 1997) the IDJ was intended to be a counterpoint to the corporate identity and glitzy graphics that seemed to take over graphic design at that time. IDJ defined *information design* in the following way: “to apply processes of design (that is, planning) to the communication of information (its content and language as well as its form).” However, as early as 1981 Hurlburt noted problems with broad terms like *information design* (p. 22):

Terms like information design, visual communication, and even graphic design are so broad in their connotations that it is impossible to use them accurately to describe specific functions. The term information design is often used to cover all of the areas of two-dimensional design that are non-persuasive. Many design schools use the term as a dividing line between ‘commercial advertising’ and more ‘respected’ forms of graphic design. This is not a completely accurate application of the term. Some design that is concerned with ‘worthy’ causes such as health, safety, and welfare may be persuasive as well as instructive, and a reasonable proportion of advertising is informative.

With reference to the display of quantitative information Tufte (1983, p. 87) noted that graphical competence demands three quite varying skills:

... the substantive, statistical, and artistic. Yet most graphical work today, particularly in news publications, is under the direction of but a single expertise—the artistic. Allowing artist-illustrators to control the design and content of statistical graphics is almost like allowing typographers to control the content, style, and editing of prose. Substantive and quantitative expertise must also participate in the design of data graphics, at least if statistical integrity and graphical sophistication are to be achieved.

In 1990 Tufte (p. 10) argued that the principles of information design are universal, and they are not tied to unique features of a particular language or culture. In 1997 Tufte noted (p. 55): “To document and explain a process, to make verbs visible, is the heart of information design.”

Easterby and Zwaga (1984) had provided a wide view of information design when they edited the proceedings from the *NATO Conference on Visual Presentation of Information* in 1978. In the preface to the book *Information Design* (p. xxi–xxii) they wrote:

Information presentation involves a wide range of professional interest groups concerned with its development and use; graphic designers, industrial designers and typographers are primarily concerned with design but will acknowledge the importance of evaluation; psychologists and ergonomists have an interest in evaluating the effectiveness of displayed information and some, but not all, will acknowledge the importance of graphic design; architects, planners and engineers have a professional interest in using information as a component in the artefacts they create for society—buildings, roads, industrial machinery and consumer products—but many may not be prepared to acknowledge the importance of design and evaluation of such information. The problem that arises is that each of these professionals approaches information display from a different standpoint—aesthetic, empirical, evaluative, quan-

titative, pragmatic, practical—and also to differing degrees, depending on the relative importance that these aspects have in relation to their own professional interest and obligations.

Kim (1997) described information design as a sub-discipline of graphic design (p. 1): “A sub-discipline of Graphic Design, Information Design addresses the ways in which audiences receive and respond to messages transmitted in a variety of classifications, including sign systems, charts, tables, maps, explanatory panels, etc.”

Information design has its origin and roots in graphic design, education and teaching, and architecture and engineering, or rather construction and production. In these broad areas people have recognised the need for clear, distinct and trustworthy presentation and interpretation of verbal as well as visual messages.

Workability and usability views

A well-designed information product will satisfy aesthetic, economic, ergonomic, as well as subject matter requirements. Mullet and Sano (1995, p. 2) remarked that: “The goal of communication-oriented design is to develop a message that can be accurately transmitted and correctly interpreted, and which will produce the desired behavioural outcome after it has been understood by its recipient.”

Pettersson (1996, 1997) provided a process-oriented workability and usability view of communication, and discussed message design principles and message design tools. Mijksenaar (1997, p. 14) argued that designers have a tendency to combine principles and values discovered by other disciplines into a workable whole that adds up to more than the sum of its parts.

According to Wildbur and Burke (1998, p. 6) information design can be described as the selection, organization and presentation of information to a given audience. This is in a wide sense. They noted that information itself could come from almost any source—a weather map, a timetable listing flight departures or a pile of statistical data. In some areas of information design, the content can be vast—as, for example, in a map—and the user extracts only what is needed for a particular purpose. In other cases, the content may lay not so much in the informa-

tion itself as in its movement in a given direction or even in its rate of change.

In their introduction to the book *Visual information for everyday use Design and research perspectives* Zwaga, Boersma and Hoonhout (1999) defined information design in the following way (p. xxxii):

... information design is first the development of an effective organization of data to change this data into information, and then the development of an instrument (often a graphic product) to transfer the information in such a way that it adds to the user's knowledge base, or guides the user's task performance in an effective and convincing way.

Note the focus on two transformations: 1) Data into information, and 2) Information into knowledge. Shedroff (1999, p. 269) pointed out that *understanding* is a continuum that leads from data, through information to knowledge, and ultimately to wisdom.

Interdisciplinary approaches

The Society for technical communication (STC) has several *Special Interest Groups*. One SIG is concerned with information design. On its WWW-homepage the ID SIG (1998) viewed information design as the application of traditional and evolving design principles in the process of translating complex, unorganised, or unstructured data into valuable, meaningful information.

The ID SIG wrote that the practice of information design requires an *interdisciplinary approach* that combines skills in graphic design, writing and editing, instructional design, and human performance technology and human factors. It is the “intellectual, creative effort” of the *information designer* that is used to discover and then articulate meanings and relationships inherent in the data in order to facilitate clear communication of information. According to Passini (1999, p. 83–84) the phrase *information design*:

is an umbrella term to cover the planning of everything—from user instructions to warning labels, from manuals to timetables, from official forms to invoices, from traffic instructions to traffic signs,

... the term *information design* means communication by words, pictures, charts, graphs, maps, pictograms, and cartoons, whether by conventional or electronic means.

And according to Shedroff (1999, p. 268–269) *information design* is the same as *common sense*, *information architecture*, *instructional design*, and *interaction design*, and it originates in publishing and in graphic design. Schriver (2012) defined *information design* as the art and science of integrating writing and design so that people can use content in ways that suit their personal goals.

Efficiency and effectiveness

Mok (1996, p. 46) argued that: “Everybody already knows what information design is, whether they realize it or not.” However, later in the same book Mok provided the following short definition of the concept information design (p. 108): “*Information design* is the arrangement of organization models to provide context and meaning for the information.”

Schriver (1997, p. 10) defined *document design* as the field concerned with creating texts (broadly defined) that integrate words and pictures in ways that help people to achieve their specific goals for using texts at home, school, or work. Wildbur & Burke (1998, p. 6) described information design as the selection, organization and presentation of information to a given audience.

According to Horn (1999, p. 15–16) information design is the art and science of preparing information so human beings can use it with efficiency and effectiveness. However, information design is experiencing a variety of *tensions*. Graphic designers (p. 25–26) “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.” And Darras (2016, p. 147) concluded: “Information design is a permanent tension between many priorities on one hand, the translation of the wealth of information to be made visible and, on the other, the semiotic and aesthetic biases induced by this translation.”

An international group of Information Design faculty, appointed by the International Institute for Information Design, IIID, argued (Simlinger, 2007, p. 8): “... information design is the defining, planning, and shaping of the contents of a message and the environments in which it is presented, with the intention of satisfying the information needs of the intended recipients.”

Sometimes information design has been marketed as *simplification*, particularly in the USA (Waller, 2011a). Simplification is an attractive concept, and more quickly understood than information design, because it calls to mind not only an action (simplifying) but also a desirable outcome (simplicity).

A search on the WWW in January 1998 for the term “information design” gave more than 6,500 hits. In August 2016 a similar search on the WWW gave 138,000,000 hits. These hits indicated that the term clearly was used for a wider concept than graphic design of information materials. Nowadays the focus seems to be on functional verbal and visual communication rather than on aesthetics alone.

Communication design

Marsh (1983) discussed the term *communication design* for “messages that work.” He made a clear distinction between an artistic approach and a design approach. These two approaches differ in their goals. Marsh commented that the artistic approach strives for perfection, while the design approach strives for workability in a cost-effective context. The design approach minimizes the need for editing and rewriting by careful planning of the work. The two approaches result in vastly different final products. The artistic approach tends to judge success by whether the product feels right and whether the critics like it or not. The design approach judges its success by whether the product achieves the objectives as specified by measurable performance objectives, within the specified resources and situational constraints. In addition, the School of Design at Carnegie Mellon University (1997) has defined *communication design* as:

the effective presentation of ideas and information by means of type and image, whether in the traditional medium of print or in

the new digital medium that supports interactive computer displays, multimedia communication technology, and information systems.

Also in this case the focus is on workability. According to Bull (1999) *communication design* examines the role of the designer as a strategic architect/visual translator in producing visual language systems that focus on appropriateness, meaning, and the end user.

Wileman (1993, p. 6) noted that: “Communication can be judged successful only when it conveys the information it sets out to convey. This is as true for visual modes as it is for verbal modes.” Here the concept “visual modes” includes all kinds of visual languages, and the concept “verbal modes” includes verbal languages. Because the solution of an information design problem is determined by the interaction between the instrumental and user constraints, Flach and Dominguez (1995) preferred to talk about *use-centred design*. According to them the success of a design depends on the coordination of the two sets of constraints: 1) Information with the appropriate means for action, and 2) The means for action with the appropriate information.

Goal and objectives

A *goal* is a measurable end result (the big picture) having one or more *objectives* (specific results) to be achieved within a specific timeframe. It is easier to measure objectives than goals.

In information design the *main goal* is *clarity of communication*. To fulfil this main goal all messages must be accurately designed, produced and distributed, and later correctly interpreted and understood by the members of the intended audience. The different processes are guided by *principles*, performed with the help of *tools* and influenced by the current and relevant *cultural* and *social contexts*.

Senders produce information materials that the intended receivers need in order to perform specific tasks. The receivers may be seen as “doers.” They may develop new experiences, skills, and understandings. Several authors have pointed out that it is always important to define clear and measurable objectives in instruction design (Fleming & Levie,

1993; Heinich et al., 1993; Wileman, 1993), as well as in information design (Mullet & Sano, 1995; Pettersson, 1998).

A performance, and a change in behaviour, must be *observable* and possible to measure. Thus it is important to avoid subjective verbs like appreciate, describe, discuss, know and understand when we write information design objectives. It is better to use verbs like apply, arrange, assemble, build, change, code, complete, compose, conduct, construct, cut, demonstrate, develop, draw, explain, find, generate, get, identify, illustrate, install, label, locate, make, modify, name, operate, pack, paste, predict, prepare, produce, put, read, recognize, reconstruct, remove, revise, sort, specify, start, type, verify, and write. All of these verbs denote observable behaviour. A few examples of performance objectives in information design may be:

- For an *instruction*: 90% of the customers should be able to follow the instructions, put the different parts together, and build a complete set of furniture within 15 minutes.
- For a *list*: 90% of the users should be able to get correct information about flight departure and arrival times within two minutes.
- For a *manual*: 80% of the customers should be able to install the new computer software within 15 minutes.
- For a *traffic information system*: 100% of motorists should recognise the signs while they are passing during night.

Of course we have to decide about actual performance figures, with respect to percentage and allowed time, in each case.

When performance is qualitative rather than quantitative, the performance may be assessed by a group of experts. It should be noted that there is an increasing incidence of law suits being brought against manufacturers in the USA. These law suits claim damages as a result of accidents occurring, or products breaking because of poor quality in the language of instruction manuals (Helyar, 1992). The courts are demanding that technical manuals, brochures, information sheets, and labels be written in *comprehensible language*, and that descriptions and instructions be *legible and readable*. Everywhere, plaintiffs' counsels are searching frenetically for sections of text and parts of pictures

that might be interpreted in conflicting ways. If a manufacturer's technical documentation is difficult to understand, he can lose a lawsuit and then have to pay large sums of money.

A young academic discipline

As previously mentioned information design is sometimes spelled Information Design (ID) as an academic discipline. There have been and there still are many views about the concept information design. Some claim that information design is a *practice*. I have claimed that Information Design is a *combined academic discipline* (next chapter). Some claim that information design is quite impossible as a concept at all. Jacobson (1999, p. 3) noted: “there is no agreement that a practice called *information design* actually exists.” Jacobson argued:

... we need a reliable lexicon and a tried-and-true theory backed up by case studies. At present, the theory is sketchy and the case studies are scarce. Too few studies of information design have been carried out to support any broad generalizations about its practice.

Jacobson (p. 6) concluded that it would take some time for a “compelling theory of information design” to be developed. This book was published in 1999. Later many more case studies have been reported in the growing information design literature. However, we have still been looking for a “compelling theory of information design,” and that theory has been really hard to find. Information design certainly exists in many countries—both as a practice and also as an academic discipline.

A traditional academic discipline, one *field of study*, is a *branch of theoretical knowledge* that is researched and taught in higher education. Nowadays several academic disciplines may be defined as parts of several *fields of knowledge*. A field of knowledge is the sum of knowledge gained from practice and theory. A limited part within a field of knowledge is an *area of knowledge*. Here a *fact* is seen as something known to be true, by experience or by observation. *Hypotheses* are propositions accepted as highly probable in the light of agreed and es-

tablished facts. A *postulate* is something fundamental that is assumed without proof as a basis for reasoning.

The boundaries of a discipline mark what falls *within* its breadth, and also what it *excludes*. Academic disciplines are often defined and recognized by university departments and university faculties, by learned societies, and also by academic journals. The criteria for the status as an academic discipline differ between universities, even within a single country. Disciplines usually have several sub-disciplines or *branches*. However, the distinguishing lines between these may be both ambiguous and arbitrary. Furthermore some disciplines “belong to” different faculties at different universities. Thus the criteria for organizing knowledge into disciplines are very much open to debate.

There are numerous competing and complex theories of *knowledge*. In this book the concept *knowledge* refers to having facts, information, skills, and understanding of a subject acquired through education, experience, learning, and training.

Most academic disciplines of today have their roots in the mid to late nineteenth century. In the early twentieth century, new disciplines such as *education* and *psychology* were added. Many new disciplines focusing on specific, and sometimes narrow, themes were added in the 1970s and 1980s.

Information Design, however, is a very young discipline, but it is not at all a new area of knowledge. Information design was not “divided away” from another discipline. Rather it was deliberately “put together” with elements from several different sources of experience and knowledge. Basically this happened at the same time in different parts of the world, in the late 1990s. I was responsible for this activity at Mälardalen University in Sweden, where Information Design got the status as an academic discipline 1999-02-15. I became the first professor of Information Design in Sweden.

Nowadays Information Design education and training range from short courses to several years long programs, some even reaching PhD-level. The discipline Information Design is also named *Communication Design*, *Document Design*, and *Presentation Design*. In the future it is

quite possible that some universities will introduce very similar subject matters in design and use other names.

Contributors and contributions

Information Design receives important contributions from more than fifty already established disciplines, research areas, and professions. These contributions may be facts, influences, methods, practices, principles, processes, strategies, theoretical approaches, and tools. I have ranked and divided these contributors into the following six groups of *supporting sciences*.

Primary supporting sciences

1. *Design disciplines* include disciplines and research areas such as ceramics design, document design, exhibition design, furniture design, graphic design, information design, landscape design, light design, web design, and many more.
2. *Communication disciplines* include disciplines and research areas such as advertising, cultural studies, gender studies, human-computer interaction, journalism, media studies, mediated communication, planned communication, technology of instruction, and many more.
3. *Information disciplines* include disciplines and research areas such as information architecture, information economics, information ethics, information literacy, information management, information quality, information retrieval, information science, information systems, and many more.

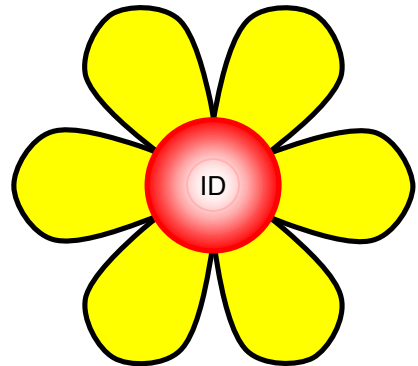
Secondary supporting sciences

4. *Language disciplines* include disciplines and research areas such as drama, lexicology, linguistics, literacy, rhetoric, semiotics, terminology, visual literacy, writing, and many more.
5. *Cognitive disciplines* include disciplines and research areas such as attention, cognitive science, didactics, memory, mental processing, pedagogy, perception, psychology, sociology, and many more.

6. *Art and aesthetic disciplines* include research areas and disciplines such as aesthetics, architecture, art history, fine art, iconography, music, painting, photography, sculpture, and many more.

Some specific areas of research and practice may actually belong to more than one group of supporting sciences.

Information Design (centre) receives contributions from six groups of established disciplines and professions. The received contributions may be facts, influences, methods, practices, principles, processes, strategies, theoretical approaches, and tools.



These six groups of supporting sciences have been the basis for the development of six *external information design theories* (Pettersson, 2014). In several cases the names of these theories resemble the names of the groups of supporting sciences.

Primary supporting sciences

1. Design disciplines → Providing theory for ID.
2. Communication disciplines → Communication theory for ID.
3. Information disciplines → Information theory for ID.

Secondary supporting sciences

4. Language disciplines → Language theory for ID.
5. Cognitive disciplines → Facilitating theory for ID.
6. Art and aesthetic disciplines → Aesthetics theory for ID.

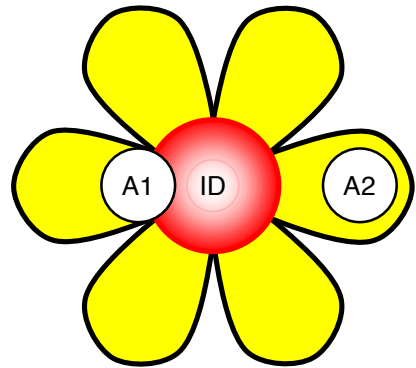
The internal information design theory and the six external information design theories are presented in the following chapters.

Inter-disciplinary and multi-disciplinary

From a process perspective new “applications” develop within new academic disciplines and professions. *Inter-disciplinary knowledge* develops between or beyond existing academic disciplines or professions and *multi-disciplinary knowledge* is associated with more than one existing academic discipline or profession.

New applications (A1) develop between Information Design (ID) and existing disciplines and professions.

New applications (A2) also develop within other disciplines and professions. In addition new applications develop within information design itself.



Some examples of inter-disciplinary and multi-disciplinary fields of knowledge are architecture, computer science, design, didactics, economics, education, engineering, gender studies, and visual literacy. At the same time established areas of knowledge become less important. All academic disciplines change over time, and eventually some of them disappear, but so far there has been a huge increase in the total number of academic disciplines.

Examples of important *information design applications* are administrative documentation, care and health care, crisis information, economical and financial information, geographical information, social information, technical information, tourist information, and public information systems.

According to Slattery and Cleary (2013) academic programmes in a young and dynamic discipline such as Technical Communication need close links with industry. In this way graduates will be appropriately prepared for their future workplaces. Lecturers need to remain abreast of disciplinary as well as industry changes to ensure that their curricula

are fresh and relevant. For the same reasons a close relation with reality is also relevant for students of Information Design.

Research

According to Palmer (1999, p. 46) a *theory* is an integrated set of statements (hypotheses) about underlying mechanisms or principles that not only organizes and explains known facts, but also makes predictions about forthcoming information and news. A theory conceptualises diverse phenomena, and systematises our knowledge about them. A theory illustrates *how* and *why* something is as it is. Lupton (2009, p. 6) noted that a theory is all about the question *why*. The process of becoming a designer is focused largely on *how*. For the purpose of this book I have used the following definition of the concept *theory*.

A *theory* is a branch of art, design or science that deals with methods, principles, and proposed explanations that are still subject to experimentation. A theory illustrates *how* and *why* something is as it is. A *workable theory* requires adequate knowledge of the specific discipline.

In this book *practice* is defined as the exercise of a profession, and the expected way of doing something.

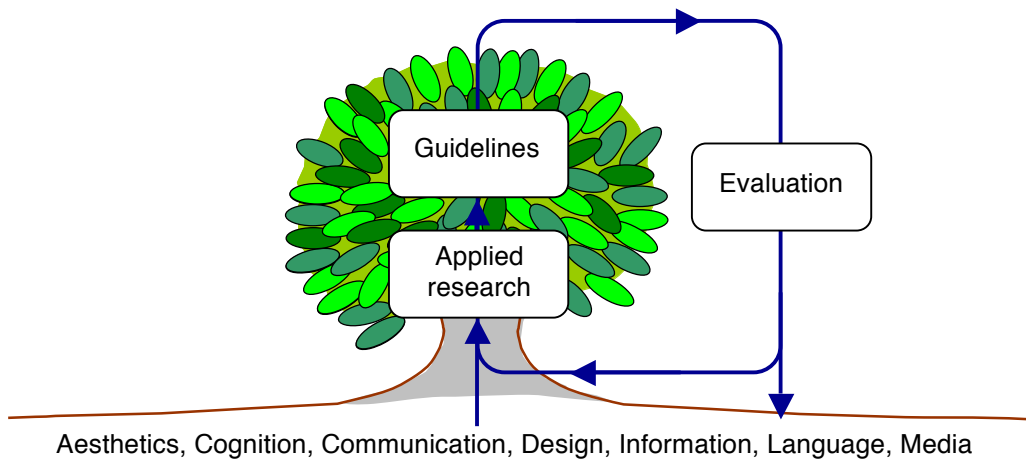
In established disciplines research is often based on one of many well-known theories. Researchers formulate new hypotheses and follow established and reliable processes for research. Sometimes results from research can be used to formulate new principles. This may not be possible in any new disciplines without any established facts, hypotheses, methods, postulates, or theories. Information design has a practical as well as a theoretical part. The same is true for architecture, dance, economics, education, engineering, fine arts, journalism, medicine, music, and even more disciplines. In all these *fields of knowledge* it is a major and difficult, but necessary, challenge to find a good balance between practical experience and theoretical knowledge.

In my own work the goal has been to study the presentation of visual and verbal messages in information and learning contexts in order to gain a better understanding of the conditions related to the de-

sign, interpretation, and use of such information. Most of my own work has been related to audience interpretation and perception of verbal and visual messages, to visual literacy, to the question of properties of visual language, and its representations.

Applied research

The study of information design is a broad area with contacts to several other areas of research. Historically many communication and language studies have mainly dealt with various aspects of verbal information presented in different media. In the past images and pictures in the messages have quite often been overlooked and forgotten. In many cases researchers have dealt with the text but not at all with the pictures. Thus research on combined verbal and visual communication has had no “natural home.” Finally information design has the ability and the power to fill this classical gap.



To a large extent research in information design consists of applied research. The results may be new guidelines, which will be evaluated.

Findings and results from research in information design can be used to formulate new design principles. These principles become the fundamental sources for development of practical guidelines. A *guide-line* is normative and it aims to streamline design processes and practical work according to a set routine. Guidelines may be issued by, and

used by, any organization to make actions more cost effective, more predictable, and of higher quality. By definition it should not be mandatory to follow a guideline. However, in practice it really is mandatory to follow guidelines in many organizations.

So far research in information design has often been oriented to solve distinct practical problems related to specific applications, rather than oriented to any known or unknown theory. Researchers are using a large number of different research methods in research on aesthetics and art disciplines, cognitive disciplines, communication disciplines, design disciplines, information disciplines, and language disciplines. Thus it is only natural that several research methods are used in information design. Some research methods are based on deduction, and some on induction. Some researchers use qualitative methods, and some use quantitative methods.

Nijhuis and Boersema (1999) studied co-operation between researchers in behavioural science and practicing graphic designers. They noted that it was not only possible to construct congruent strategic models of the two occupations, but they also showed that the corresponding tactics were remarkably similar. Differences in attitudes towards time and money only existed at the operational level, where specific skills and methods are used to achieve intermediate results.

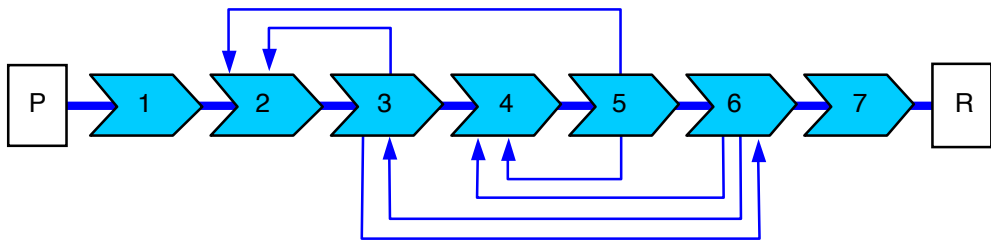
Research in information design has a pragmatic perspective on different kinds of knowledge. Each research problem needs its specific research method. New findings are tested and the results are confirmed in different environments and in different situations. To describe research in information design we may use words like *creativity*, *flexibility*, and *practical testing* in both experimental and in real life settings. Working with research in information design is a challenging occupation partly due to this complexity.

According to Batley (2007) evaluation research in information design may be approached as follows: 1) Experimental, 2) Goal orientation, 3) Responsive, and 4) User orientation.

A research process

A process for research in information design is the foundation for a certain stability and quality. This process has seven sub-processes. The first sub-process is an analysis of the problem. The following sub-processes are planning and manning the project, study of literature specially relevant for the problem, collection of data, analysis of data, interpretation and discussion of results, and publishing of a final report. Study of design literature may be a parallel activity throughout the whole research process.

Quite often we need to disregard traditional praxis within already established disciplines and dare create new research methods that are exactly designed to fulfil the needs of the information design problem at hand. We need to be able to collect such data that are necessary to answer the research questions in each specific case. Obviously this may include certain risks and it may be rather complicated. However, it is necessary, in order not to get caught in disappointing and disturbing dead ends.



This picture shows my research process for applied research in information design. The seven sub-processes between the formulation of a problem (P) and a finished report (R) are: 1) Analysis of the problem, 2) Planning the project, 3) Study of literature, 4) Collection of data, 5) Analysis of data, 6) Interpretation and discussion, and 7) Publishing.

Depending on the project characteristics such as knowledge areas, purpose, and research questions, the researcher selects the most suitable methods. The greatest influence of a creative approach seems to occur mostly in the beginning of a research project. The amount of in-

fluence seems to decrease as the project evolves. This may be due to the fact that more guidelines are taken into consideration as the project becomes more concrete. Analysis and performance are woven together but does not occur at the same time.

Since information design is a broad area it is a good idea to study it from different perspectives, such as content, communication, context, design, knowledge, and representation.

Creating a leverage effect

In any new academic discipline, and in any new area of knowledge it is hard to create a basic and unanimously shared body of knowledge. A new area of research may engage a number of individual researchers. However, these researchers may typically be working in several different parts of the world. Furthermore, they may be working individually on their own projects and their own research problems. Most of these researchers may not have any contacts at all with other researchers with similar interests. Some researchers may, however, occasionally have some cooperation with one or more other researchers.

All researchers produce their own papers and various reports. Typically they have a hard time to find somewhere to publish their results. This is especially true for new academic disciplines and new areas of knowledge with no or limited prior traditions. Existing scientific journals often hesitate to publish the results generated by these researchers, scattered around the globe. Thus it is also hard to distribute new findings and it will take a long time to build a common body of knowledge. Not many people will be able to read these documents.

Obviously the quality of these individual documents may be quite different. Since everything is new there are no established systems for peer reviews. As a result some of the papers may only have a very limited value. But, again, not many people will be able to read these papers. When a group of people with similar research interests meet, one of them may come up with the idea of organizing a meeting, a seminar or even a conference. This may be the beginning of a “special interest group,” a “SIG,” within an already existing organization. It may also, in fact, be the beginning of a new organization. When this group of people

decide to study a common theme and present their findings at a future meeting they suddenly introduce a very strong way to boost research in this selected area.

We have seen many times in academia and in business, that this may be a very good way to start work in a new area of knowledge, not yet developed. Organizing a conference may mean that 15, 20, 25 or even more people will focus on the same theme and the same problem at the same time. This is likely to result in an important “leverage” which may facilitate a major advancement in the area. Suddenly it is possible to get a combined and strong movement that may result in a major step forward. First of all the people that are invited to the meeting will produce a large amount of new knowledge. The economic value of this may be substantial.

During the conference it is possible for researchers to get feedback on their own research. It is also possible to meet other people with similar interests and start new projects. This is a quite common result. After the conference it is important to produce some kind of documentation. It is important to make this documentation available for those with an interest in the area. When such a conference is successful, it is natural to discuss a new theme, but also to organize a subsequent conference. Next time there may be even better focused papers. Then some of the papers will be produced by groups of researchers. The area of research may gradually grow and possibly also drop off new areas.

Research perspectives

In information design some studies are concentrated on the way a *representation* should be designed in order to achieve *optimum communication* between the sender and the receiver. We can study the whole communications process, for example with respect to economical and/or social aspects. We can also study the sender and the processes for producing an original, a master, and an edition. We need to study representations and the relationships of the message and media. How do the receivers understand and react to verbal and visual messages?

A *content perspective* includes several types of information sets, such as administrative documentation, brief messages, factual informa-

tion, informative entertainment, and instructions. It is also possible to include advertising and propaganda, as well as teaching aids in this group.

The *context* in which a message is presented has a major impact on the way that the message is perceived. For example, the context may consist of music, and sound effects. A context perspective on information design includes the *internal context* (inner context), the *external context* (with close context and social context), and a *personal context*.

When we read a book or view projected images the lighting in the room may exemplify the *close context*. Another example of this is students who work together on assignments. These students take part in a *cooperative learning process* (Kristiansen et al., 1994). In this example the other students and teachers, the actual buildings, and the books in the libraries all provide important parts of the close context that is important for efficient learning. In another study Donaldson and Acheson (2006) found that learners construct their understandings by collaborating with classmates and interacting with information, the various tools, and visuals provided within a virtual reality environment. The entire communications situation, i.e., the senders and the message, the receivers and their circumstances all provide the *social context*.

Each receiver will place available information in a wider, expanded, *personal context*. Receivers are apparently capable of sensing far more information than is explicitly displayed in a given picture. Subjects express opinions about circumfluous events on their drawings. They also tend to feel that their particular interpretations are the correct ones.

When we view a film or a television program our attention is *either* on the image or on the sound. This is even more obvious when we look at a multi-image slide and film presentation. As soon as the film starts, our attention is directed towards the movement in the film from the surrounding stills. It is impossible for viewers not to be influenced by the film and the moving images. Some computer programs contain advanced animations with interaction between words, images, and even sound. We may also discuss the relationships between the image elements within a single picture.

When our listeners and readers get the “wrong impression” it may be very hard to change this later on. Thus it is important to design and prepare presentations for each specific situation. A *design perspective*, or an *execution perspective* includes graphic design, image design, light design, sound design, spatial design (or expo and event design), text design, and time design (the ability to deliver information when the user actually needs it).

Infology theory

For more than hundred years ago the influential Russian art theorist and painter Vasily Kandinsky (1866–1944) 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...” Kandinsky was referring to a *theory of harmony* and a firm artistic basis. It is still certainly difficult to formulate a complete theory, and not only with reference to art, beauty and harmony, but also with reference to communication, information, and design.

Combined disciplines

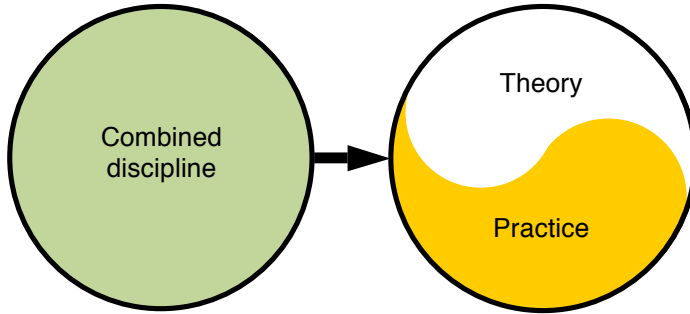
Traditionally *science* is seen as a systematic enterprise that builds and organizes knowledge in the form of testable explanations and predictions about the universe (Wilson, 1998). In *applied science* people apply basic existing scientific knowledge to develop practical applications for different needs. An example of this is engineering and development of technology. We may view an applied science, as a “combined discipline,” as a “practical theory,” or as a “theoretical practice.”

Information design is complementary to “information technology” in the same way as architecture is complementary to “building technology” (Simlinger, 1999). Also dance, design, economics, education, fine arts, journalism, medicine, music and theatre, are examples of areas that have a practical as well as a theoretical part.

Combined disciplines are complex areas to research and study. Numerous researchers have borrowed parts of their theories from other fields in order to build theories in new fields. It is obvious that Information Design as an academic discipline needs to incorporate theoretical contributions from other disciplines.

Yin and yang, or yin-yang, is a concept used in old Chinese philosophy to describe how some seemingly opposite forces are interconnected and interdependent, and how they give rise to each other. We think of many natural dualities, such as life–death and light–dark, as physical manifestations of these concepts. Yin and yang can also be seen as complementary forces interacting to form a dynamic system in

which *the whole is greater than the parts*. In my view the combination *theory–practice* is such an example in Information Design, and in information design.



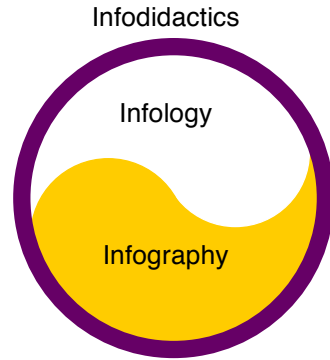
This model shows the relationships between theory and practice in Information Design, as well as in the other design areas and disciplines.

Infology

As an academic discipline, Information Design rests on a *foundation*, which I have expressed (Pettersson, 2014, p. 9) using four *basic statements*: 1) ID is inter-disciplinary and multi-disciplinary. 2) ID is multi-dimensional. 3) Theory and practice co-operate in ID. 4) There are no firm rules in ID. In my opinion these basic statements are more than theories. These statements represent facts that are established and recognised by people who are working in the field around the world.

The theoretical part of Information Design, as well as message design, is called *infology*. It has defined infology as the “science of verbal and visual presentation and interpretation of messages” (Pettersson, 1989, p. x; 1993, p. xi). On the basis of man’s prerequisites, infology encompasses studies of the way a combined verbal and visual representation should be designed in order to achieve optimum communication between a sender and a group of receivers. Infology contains both *theoretical elements* (descriptive), as well as *normative elements* (prescriptive).

This model shows how infodidactics (teaching), embraces infology (theory), and infography (practice). View this as a cross section through a sphere.



Complicated language, in both texts and pictures, will impair the understanding of the message. Thus producers of information and learning materials can facilitate communication, and also the learning processes of the intended receivers. Tonfoni (1998, p. 16) concluded: “The way information design is designed today will in fact deeply affect people’s learning processes and their ability to access knowledge in a very wide sense”.

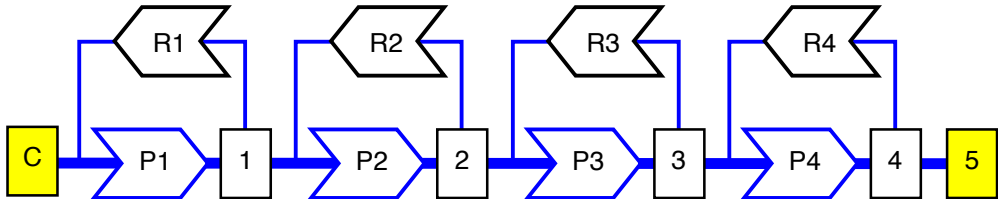
Active voice, attention, clarity, comprehensibility, consistency, emphasis, information ethics, legibility, memory, perception, precision, processing, quality, readability, reading value, simplicity, structure, and unity are all *key concepts* in information design. Any graphic message should be legible, readable, and well worth reading for the intended audience, and any audio message should be audible, distinct, and well worth listening to. Every information designer needs to have theoretical knowledge as well as practical skills.

Information design processes

People have been designing, planning and executing information sets, information materials, and messages in all times. An information design process starts with a commission. The goal is to produce a final design, to be used as a master for production of a number of representations or artefacts.

My own “information design and message design model” includes the following four process activities: 1) Analysis and synopsis, 2) Production of draft, 3) Production of script, and 4) Production of original

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



The creative message and information design processes include four different production (P1–P4) and review activities (R1–R4). 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.

1. Analysis and synopsis

During an introductory planning and analysis phase it should be possible to analyse the intended message, analyse the intended information interpreters and the information requirements, define the purpose and the objectives, organize the work, and select a suitable method for framing of the verbal and visual message. Unfortunately, many production teams may spend too little time and effort on this very important phase. Different occupational roles are presented in the section *Competence areas* later in this chapter.

When the objectives, the purpose, the receivers, and the type of representation for the intended message are decided, it is possible to start working on a synopsis. A subject matter expert or a work group produces the synopsis, an overview of the forthcoming information or learning material. It is important, already at this stage, to decide on a suitable structure of the material. This creates the conditions for the material to have a good *reading value* for the intended readers. However, what is interesting to one person may be dull to another, and the

same message may be interesting at one instance but uninteresting at another occasion. Each group of readers selects information material on the basis of personal preferences. Reading value in the written word is comparable to *listening value* in the spoken word.

The contents and the structure of the synopsis may be reviewed and approved by an expert or by a special committee with sufficient subject matter expertise.

The information designer needs to acquire deep knowledge about the broader context in which the final designs will take place in order to anticipate reactions of those who exert power over projects in large bureaucratic organizations (Schriver, 2011a). Adams (1999, p. 19) concluded that designing good information-giving material is a difficult task, but it is one that can be assisted greatly by appropriate *usability testing*. Users of information products still largely blame themselves when faced with poor designs. Thus a push for a 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, photographs, and video.

Zimmermann and Perkin (1982) pointed out that the intended audience should have the final say about the content, illustrations and sequences that are used. Administrators and others indirectly connected with the project usually will have an abundance of suggestions for revision, or state that they do not understand the message. But, the materials were not designed for this group. Not all kinds of technical information could be transferred primarily through illustrations.

Members of the group of *intended users* may form one or more *focus groups*. The focus groups should be asked to discuss and review the information material at the various steps in the production process. Focus group sessions may be helpful in answering questions of how and why people behave as they do, and how they understand the subject matter in an information material.

It may often be a good idea to ask members of the group of intended users to actually use the product in a realistic situation. This exercise may be videotaped for further analysis. It is also possible to provide the test persons with a set of realistic assignments. They may be

asked to communicate their thoughts on how and why they chose to proceed in certain ways. We may also interview the test persons, and give them questionnaires to fill in. Results from these tests should be the basis for revision of next generation of the information material.

When text and pictures are being produced for informative purposes, it may be a good idea to start by trying to “visualize” the information to be conveyed to the readers. “Visualizing” a message means that you attempt to materialize it in an effective synthesis of words and pictures. Visualization is usually a complex task, never a single act on its own, and it requires the collaboration of several different parties. Here we can note the following six steps:

1. *Requirements.* Analyse the commission and the requirements. Define what the sender wants to achieve. Find out about the project budget.
2. *Receivers.* Define the intended receivers of the information message. Consider age, gender, socio-economic factors, and views expressed by (previous) intended receivers.
3. *Objectives.* Define the objectives for the message.
4. *Representation.* Select the most suitable medium for the message.
5. *Production.* Organize the work. Select a method for framing of the verbal and visual messages. Produce synopsis for text and pictures.
6. *Reviews.* A *subject matter review* will ensure that the content is relevant to the intended audience. A *pedagogical review* will ensure that the material is well structured.

When applicable, the results from tests on previous editions of the information materials should be the basis for production of new information sets. Interviews with information designers showed that they feel that they have good possibilities to use their creativity during the first sub-process in the design of information. Usually this possibility will decrease during the work in the following sub-processes. The number of possible alternatives decreases during the process that restricts the creative possibilities. Another important reason for this is the substantial increase in cost for each sub-process.

2. Production of draft

The subject matter experts produce the basis of the very first “raw draft” (sometimes simple sketches), from which the subject matter experts, technical writers, and graphics editors may produce a first draft with outlines for the pictures. Here we can note the following six steps:

1. *Versions*. Establish a system for control of the various versions of the documents. Use a document numbering system.
2. *Text*. Study the raw draft. Work with text design. Write the text. Create and use standard templates. Use only one word processing system within the project.
3. *Pictures*. Study the raw draft and the text. Work with image design. Draw simple sketches with clear explanations for drawings and photographs.
4. *Integration*. Organize interplay between text and pictures.
5. *Graphic design*. Prepare work with typography and layout. Bring any last-minute ideas into the process. Prepare the preliminary manuscript.
6. *Reviews*. A subject matter review will ensure that the content is correct and relevant to the intended audience. A pedagogical review will ensure that the material is well structured and comprehensible. The information material must also be highly legible and readable, and have a high reading value. When possible members of the group of intended users should be asked to review the draft.

3. Production of script

All necessary work on the text and on the schematic pictures as well as ideas for important photographs arising from the comments made by the reviewers should be incorporated in the information material in this phase, the production of the script. When the script is ready, the information material looks like completed information or learning material. We can note the following seven steps:

1. *Versions*. Control the versions of the document.
2. *Text*. Edit the manuscript into its final version.

3. **Drawings.** Order or produce all the originals based on the previously approved sketches.
4. **Photographs.** Produce prints that are suitable for reproduction in accordance with sketches or test shots.
5. **Graphic design.** Work with typography and layout.
6. **Reviews.** Review the verbal and visual materials. Make an overall check of linguistic usage, writing style, terminology, typography, and layout before the script can be confirmed as the original. The design and testing of non-verbal material are more complicated and require much more time than the development of comparable verbal materials. Simple does not mean easy. It is a good idea to invite members of the intended audience to evaluate the final texts, drawings and photographs, and to listen to their comments.
7. **Copyright.** Be sure to check copyright clearance for all materials before the technical production starts. This may save a lot of trouble later on.

4. Production of original and master

Before the original can be confirmed as the master, where the text and the visuals finally are brought together, there should be an overall final check according to the following six steps:

1. **Versions.** Make sure that the final versions of the various parts of the documents are used for the originals.
2. **Text.** Check the quality of the technical production.
3. **Drawings.** Check the quality of the technical production.
4. **Photographs.** Check the quality of the technical production.
5. **Graphic design.** Check the quality of the technical production.
6. **Corrections.** Correct any errors.

Information design principles

In information design all principles should contribute to the design and development of effective and efficient messages, information sets and learning materials. Information design processes and sub-processes are influenced by *information design principles*. These principles can be seen as the basis, the origin, and the fundamental sources for develop-

ment of effective, efficient, and normative *guidelines* for design of verbal and visual messages and information materials. The sender should:

1. Adapt the verbal and visual message to human attention and perception in order to facilitate interpretation, and understanding.
2. Edit the verbal and visual message for better comprehensibility and easier understanding. Editing for a selected target group includes clarity, consistency, message structure, simplicity, subject matter depth, and also unity.
3. Consider the costs for the verbal and visual message.
4. Secure the quality of the verbal and visual message.
5. Respect copyright, ethical rules, and all media-specific ethical guidelines.
6. Use the appropriate tools for information design.

As previously mentioned Tufte (1990, p. 10) argued that the principles of information design are universal, and they are not tied to any unique features of any particular language or culture. Lipton (2007, p. 9) provided the following principles for information design:

- *Consistency* (is there a design style sheet at work-for example, does one headline look like another?)
- *Proximity* (does the amount of space between elements reflect the relationship between the elements?)
- *Chunking* (are related elements grouped and separated from others to make them digestible, instead of dauntingly unbroken?)
- *Alignment* (does every element line up with some other one?)
- *Hierarchy* (does the most important information look most important-placed at the top, bigger, bolder, or emphasized in some other way?)
- *Structure* (is the information presented in a sequence that will make sense to the audience?)
- *Balance and eye flow* (is there a clear starting place, and do the type and layout choices support the movement of your eye through the material?)

- *Clarity* (is the writing clear and concise, free of unnecessary jargon or undefined terms, and at the right level for the audience?)

My own research of information and message design processes (Pettersson, 1993, p. 88; 1997, p. 110–118; 2002, p. 44–45; 2010b, p. 167–182) have resulted in four groups with a total of sixteen *design principles* for information and message design. These groups are:

1. *Functional principles*. This group includes six principles: 1) Defining the problem, 2) Providing structure, 3) Providing clarity, 4) Providing simplicity, 5) Providing emphasis, and 6) Providing unity.
2. *Administrative principles*. This group includes four principles: 1) Information access, 2) Information costs, 3) Information ethics, and 4) Securing quality.
3. *Aesthetic principles*. This group includes two principles: 1) Harmony, and 2) Aesthetic proportion.
4. *Cognitive principles*. This group includes four principles: 1) Facilitating attention, 2) Facilitating perception, 3) Facilitating processing, and 4) Facilitating memory.

A total of 150 practical information and message design guidelines are linked to the sixteen design principles. These guidelines may be used in the production of information and learning materials as well as in instructions. However, we need further development of clear guidelines for design and development of messages for information. In order to do this we need theories that are relevant to information design.

Harmony	Information access	Information costs	Information ethics
Aesthetic proportion	Facilitating attention	Facilitating perception	Securing quality
Defining the problems	Facilitating processing	Facilitating memory	Providing emphasis
Providing structure	Providing clarity	Providing simplicity	Providing unity

The four groups of information design principles are aesthetic principles (top left), administrative principles (top right), cognitive principles (middle), and functional principles (bottom).

1. Functional principles

As previously mentioned there are six functional design principles: 1) Defining the problem, 2) Providing structure, 3) Providing clarity, 4) Providing simplicity, 5) Providing emphasis, and 6) Providing unity. Guidelines that are based on these principles will assist the information designer to design information sets that are well suited for the intended receivers.

During an introductory analysis and planning phase it is possible to organize the work, analyse the sender, analyse the intended receivers, analyse the intended message, and select a suitable medium. The message and the medium form the representation.

A sender, or “information provider,” may be an advertiser, an artist, an instructor, a subject matter expert, a teacher, a writer, a film or television producer, or anyone else who wants to convey an intended message to one or more receivers, or “information interpreters.”

Sometimes the sender will design messages and develop information sets. However, quite often these tasks are entrusted and left to other people who may be more qualified for this work. The first parts may be left to an information designer, who needs to define what the sender wants to achieve, and when this is to happen. It is also important to find out about the project budget, as well as all other requirements.

Within an organization it is usually necessary for the sender to employ a total view of communication and information. Information should be related to the overall activity goals for the organization. Messages in different media should be designed to work together. The effectiveness of a message depends on the medium, on the type of information content, and also on the amount of time that receivers are permitted to interact with the information set. With respect to the selected message the information designer must define the objective and the purpose of the message, always keeping the intended receivers in mind. The information designer will also collect and review necessary facts for later use in the design process, and consider the use of graphic form, images, and text.

There are always several opportunities to convey a specific message. Audio, text, and visuals compete for the attention of the intended receivers. Thus the information designer will have to select the most suitable medium for the message, produce synopsis for text, pictures, and sound, and adopt the graphic design to the selected medium. Each medium has its own particular advantages and disadvantages.

The smaller a group of receivers is, the greater our ability is to describe it in a reasonable fashion. More individual characteristics are manifested in large groups. There are literally many thousands of possible groups of receivers. It is important for the information designer to carefully define the group of intended receivers, and collect data about age, culture, gender, and socio-economic factors. When possible, the information designer will also consider any feedback that may be expressed by any previous receivers. The more information we have on a particular group, the greater our ability is to address this group in such a way that our messages are understood.

The *context* in which a message is presented has a major impact on the way that a message is perceived. Each context will influence the interpretation of the message. Therefore the information designer will have to define the external and internal contexts of the message, and then define how the context may influence the interpretation of the message. Each context will influence the interpretation of the message. Often we may not be able to attend to more than one stimulus at a time.

2. Administrative principles

As previously mentioned there are four administrative principles: 1) Information access, 2) Information costs, 3) Information ethics, and 4) Securing quality. Principle 2 is presented in the chapter *Design disciplines*. Principles 1, 3 and 4 are presented in the chapter *Information disciplines*.

3. Aesthetic principles

As previously mentioned there are two aesthetic principles: 1) Harmony, and 2) Aesthetic proportion. These principles are presented in the chapter *Art and aesthetic disciplines*.

4. Cognitive principles

As previously mentioned there are four cognitive principles: 1) Facilitating attention, 2) Facilitating perception, 3) Facilitating processing, and 4) Facilitating memory. These principles are presented in the chapter *Cognitive disciplines*.

Infography

The practical part of information design is called *infography* (Pettersson, 1989, p. 206; 1993, p. 173). It includes all the intellectual and practical work and skills needed for design of messages. The term *infography* was initially used mainly for information graphics in newspapers and in television, but it has since been used in a wider perspective for presentation of all kinds of verbal and visual messages in all media.

Data are collections of facts. Data may consist of numbers, visuals, or words, often stored on paper or in computer systems. Collections of

data are often complex, unorganised, unstructured and because of this often hard to understand. On the other hand high-quality information is correct, credible, relevant, and easy for the intended audience to access, interpret and understand. An intended audience may range from just a few individuals up to many thousands.

There are different types of messages. A newspaper and a textbook generally use both printed pictures and printed words. A television programme, and a multimedia presentation employ images, sounds, and words. Information and message design processes and sub-processes are performed with information and message *design tools* suitable for the type of representation that was selected during an early phase.

Main information and message design tools include words combined to texts (printed and spoken), symbols, pictures (drawings, photographs and video), graphical form (typography and layout), sound and sound effects. These tools have different properties that offer and restrict the foundations for communication.

Competence areas

There are many different skills that may be needed in the design and production of information and learning materials. A number of “competence areas,” are the same for work with any information material. Different people work on different assignments, to some extent at the same time. In a large project there may be a need for many different skills, such as a project manager, a subject matter manager, a project secretary, and a number of sub-project leaders. There may also be editors, graphic designers, information designers, illustrators, linguistic consultants, pedagogues, photographers, subject matter experts, subject matter reviewers, technical writers, translators, web-masters, and even more occupational roles. In a small project it is usually not possible to employ a large number of experts. However, also in small projects we need to organise various reviews in order to meet quality standards.

The *project manager* is responsible for the project budget, for coordinating and controlling the whole project, and for reporting to the

management and to other control groups. The project manager may be a skilled information designer. The *subject matter manager* may be responsible for outlining the subject matter contents in the whole project, and dividing the parts between the different information materials. In large projects, there may be several subject matter managers involved.

The *project secretary* is responsible for maintaining continuous contacts between the different sub-projects, for writing minutes from meetings, and maybe also for the final delivery of the completed information material. *Sub-project leaders* are responsible for their respective parts of the total information materials. They have to deliver their documents on time. The sub-project leaders have continuous contact with all parties involved in the whole process. One important aspect is copyright clearance for all materials; audio, text and visuals, brought into the design process.

Subject matter experts produce the very first, “raw drafts” with the necessary subject matter facts and information. Since it is important to secure the quality of the information or learning materials the subject matter experts may also take part in the reviews. *Technical writers, editors, and information designers* work on the texts and materials delivered by the subject matter experts and by the *information brokers*, and they produce finished texts. This work encompasses the whole spectrum from simple editing of well-written texts, to completely re-writing texts to convey the intentions of the subject matter experts to the intended readers.

When there are many contributors to a particular section, it is important to bring a uniformity of linguistic usage and writing style across the complete information or learning material. *Linguistic consultants* may do this. They are responsible for the overall coordination of the linguistic usage and writing style. The linguistic consultants, partly, check the linguistic usage to an agreed standard, and partly, check that the writing style is consistent to an agreed standard. The linguistic consultants may also look at whether the linguistic usage and writing style are used in a uniform way. *Terminology experts* may review the information and learning materials with respect to the use of consistent

terminology. In certain cases, it may be necessary to get the help from skilled *translators*.

Graphics editors work on the schematic pictures that are delivered by the subject matter experts and writers. They produce the finished schematic pictures. The work encompasses straightforward editing of well-drawn pictures to creating completely new pictures, to convey the intentions of the subject matter experts. There may also be a need for professional filmmakers, fine art artists, illustrators, photographers, video producers, and several others to produce the visual images that are needed.

Pedagogues should review any learning material. They will check that it is sufficiently legible and readable, and that it really is possible to understand by members of the intended audience. The learning material shall also have a good reading value.

Graphic designers are responsible for layout and typography in the information and learning material. The graphic designers may also produce the final master for printing or publishing online.

Subject matter reviewers review the subject matter contents in both texts and pictures. It is very important that facts are technically correct and relevant to the situation. Patents and other intellectual property matters are an increasingly important source of income for many commercial organisations. In commercial technology projects the *patent officers* should first review any information material, with respect to patent matters. Members of the group of intended users should take part in the production process. They should be asked to discuss and review the information material at various steps in the process.

The information designer

A competent and skilled information designer is a *professional communicator* with competence to transform loads of data into high-quality information. He or she has to identify the communication and information problems and create plans, with schemes and specifications, to solve the problems. He or she may often work as a project manager. The task is often to coordinate production of graphic design,

visuals and texts, but sometimes also the use of light, sound, space and time, for the professional presentation of messages in different media.

Core competencies

Simlinger (2007) reported on the results from the international project “idX Development of International Core Competencies and Student and Faculty Exchange in Information Design” within the EU/US Co-operation Program in Higher Education and Vocational Education and Training. In this project Information Design faculty listed the essential competencies for an information designer.

I. What graduates know:

- The theories.
- The theories and methods, which govern the design and interpretation of information (methodical and theoretical dimension of information design core competencies).
- All relevant facts and tools for qualified professional activities in the field (Practical dimension of information design core competencies):
 - The properties, which constitute effective information.
 - The facts, tools and skills needed for the structuring, rendering and applying of information.
 - The capabilities of information and communication technologies.
 - The related insights gained through research done in the field of cognitive and social sciences.
 - Existing conventions and applicable legislation and standards.
 - The implications of business management.
- The social demands underlying successful professional practice (Social dimension of information design core competencies).

II. How information designers design information and develop information systems

Information Designers:

- Identify the goal(s) to be met and tasks to be performed.

- Define the user(s), either through appropriate methods, such as observation, interviews, and development of personas.
- Compose the information using verbal, pictorial, acoustic, haptic and/or olfactory elements, which they shape, and structure according to principles of cognitive and perceptual psychology.
- Pay due regard to the media and reproduction/distribution processes to be employed within an existing or to be developed communication infrastructure.
- Integrate feedback.
- Document the information elements, the objects to which they refer, the processes involved and the respective responsibilities of those who have to safeguard the production and maintenance of related materials and systems.
- Initiate the testing of use and usability, evaluate the test results and refine the information accordingly.
- Assist clients with implementing and with performance-focused monitoring of the information.
- Provide information on the value dimension of measured results.

In large projects information designers often work as project leaders. In smaller projects they will have to perform several occupational roles.

Cognitive aspects

Passini (1999, p. 87) noted that the “knowledge base for designing information emerges from the behavioural sciences, in particular from work in cognitive psychology. It is also linked to ergonomics and environmental psychology.” The observations on which the “Gestalt theory” is based form a basic part of the graphic designer’s craft knowledge (Waller, 1987). This is also true for the information designer.

Results from several experiments show that learning is maximized when the contents are the same in audio, print, and visual channels (e.g. Branch & Bloom, 1995; Dwyer, Cisotto and Boscolo, 1995; Dwyer & Canelos, 1988; Houts et al., 2006; Levie and Lentz, 1982; Paivio, 1983). The content, the context, the format, and the structure of a visual influence the viewer’s ability to perceive its message.

Cultural aspects

Many people are working with information professions. Editors, information designers, and journalists may have similar basic knowledge about methods, processes, and techniques. However, their roles differ in society. Professional roles give each group a *special identity* and make different demands on their experience, know-how, and loyalty. The loyalty of an information-provider is to her or his employer. The loyalty of a journalist should be to her or his readers, listeners and viewers rather than to the employer.

Experienced information designers know the applicable legislation, the existing conventions and standards in different countries and in different cultures (Simlinger, 2007). They know which kind of properties constitute effective information.

According to Schriver (2011b) professional communicators recognize that communication artefacts are often re-contextualized in unpredictable ways. Each time a text is reused, it becomes divorced from the social context in which it was produced. This is also very much true for photographs that are offered by various agencies and archives. Millions of pictures are produced every day. McDougall and Hampton (1990, p. ix) concluded that photographs needs to be presented in arrangements and sizes that will attract and hold reader interest. There is an optimum size for each visual. A photograph can look like reality, but it is always a representation.

Professional communicators can juggle multiple organizational constraints (such as deadlines or lack of funding) and multiple representations of the content (what the boss wants, what the client needs, and what the author thinks is best) and still maintain a focus on the stakeholders' needs.

Design aspects

The task of designing complete information sets and information systems may often be far too overwhelming for one single individual. For that reason a team of people, with competence and skills in different areas, are often working close together. A professional information designer may often work as a project manager. Information designers

continuously develop tacit knowledge of what works in different situations.

Baer and Vaccara (2010) explored the ways designers have used effective devices or tools such as colour, graphic elements, grouping, rhythm, scale, structure and weight, as well as motion and sound, to develop powerful information design solutions. Case studies range from print projects to interactive and environmental information systems.

Information aspects

Experienced information designers know the methods that govern the interpretation of data and the design of information as well as relevant facts and tools for qualified professional activities in the field (Simlinger, 2007). The experienced information designers also need the necessary knowledge of applicable communication technologies, media production and distribution processes.

According to Schriver (2011b) professional communicators possess rich schematic and tacit knowledge about genres, processes, stakeholders, symbols, and tools. Professional communicators are metacognitively aware of what they need to know and have strategies for getting that knowledge. They acquire rich knowledge of verbal, visual, and typographic text features and are skilled in combining verbal and visual resources.

Rhetorical aspects

Information designers understand the importance of high quality illustrations, layout, texts, and typography. According to Schriver (2011b) professional communicators have rich rhetorical memories about the people they have designed information sets for. They are both verbally and visually fluent, and possess a large repertory of semiotic resources (images, numbers, sounds and words).

Information designers are able to fuse disparate items of content into a coherent whole. They need to decide what to say, how much to say, how to say it and why they have to make specific choices in particular rhetorical situations. Information designers strive to provide the

“right” kind of content at an appropriate level of detail in the most suitable media for the intended audiences. They expect that their work will be circulated and used in various formats, and in different media.

Social aspects

Information designers need to have good social skills. As previously mentioned they often work as *project managers* together with teams of highly skilled editors, graphic designers, illustrators, linguists, non-fiction writers, photographers, picture editors, subject matter experts, technical writers, and translators. Information designers need to understand the social demands underlying successful professional practice (Simlinger, 2007). Waller (1995) discussed the mutual incomprehension among designers and psychologists. And noted (p. 6):

Designers are frequently appalled by the poor standard of stimulus material used by psychologists, while psychologists are frustrated by designers’ lack of a theoretical framework, their lack of evidence, and their apparent un-willingness or inability to articulate their processes.

Later Waller concluded (p. 9):

What underlies this apparent incompatibility of psychology and design is a fundamental difference in the kind of knowledge they employ. Scientists are committed to building explicit knowledge that is public and accountable. Designers are committed to building tacit knowledge that is private and unarticulated. Explicit knowledge is taught by explaining. Tacit knowledge is taught by showing, and learned by doing.

According to Schriver (2011b) professional communicators are able to *read the context* and scope out cultural and social resources. They are strategic in building alliances with others who may help them to achieve long-term goals for design processes and products.

Information ethics

Information ethics is one of the *administrative principles* in information design. This principle concerns copyright and image manipulation.

Copyright

As a rule the information designer *must respect copyright* as well as other laws and regulations that are related to design, distribution, production, storage, and any use of information materials. This concerns the use of artwork, illustrations, logos, lyrics, music, photographs, specific sounds, symbols, texts, trademarks, video recordings, and any other elements. It is also important to honour business agreements, and respect ethical guidelines.

The rights of copyright holders are protected according to agreed ethical rules, international conventions, and terms of delivery. Full copyright protection for a “work” or a “production” requires creativity, fixation, and originality. For literary works the copyright protection duration is the length of the authors’ life plus another 70 years. In many countries all kinds of pictures with artistic or scientific merit also enjoy protection for 70 years after the death of the copyright holder. Drawings usually belong to this category.

In order to convey high-quality information to the user the information designer sometimes will have to suggest some modifications, and ask original authors, draftsmen, and photographers for permission to make changes in their original works. In some cases the information designer may also be a stakeholder as far as copyright is concerned.

Image manipulation

Image manipulation implies the improper control of people's perception of a given reality through the use of pictures. The ethical rules for press, radio and television clearly warn against falsification or manipulation of picture content through misleading captions, odd montage, or suspicious trimming. Photo manipulation and stylistic embellishment can easily be used to create dishonest figures and tables. Presenting inauthentic pictures as though they are real documentary material is

clearly forbidden. Normally we are allowed to crop an original picture, as well as enlarge, as well as reduce its size.

The party purchasing the right to use some pictures in a specific publication is responsible for their proper use. Despite these rules, clear violations occur all too often. In production of news the editors should ask themselves if every photo meets the ethical standards of responsible journalism (McDougall, 1990). The *Associated Press* has adopted six photo manipulation guidelines to prevent dishonest reporting (Cifuentes, Myers and McIntosh, 1998, p. 170):

1. The content of a photograph will never be changed or manipulated.
2. Only the established norms of standard photo printing methods such as burning, dodging, black-and-white toning, and cropping are acceptable.
3. Retouching is limited to removal of normal scratches and dust spots.
4. Serious consideration must always be given in correcting colour to ensure honest reproduction of the original.
5. Cases of abnormal colour or tonality will be clearly stated in the caption.
6. Colour adjustment should always be minimal.

These photo manipulation guidelines can also be used in information design. A good summary may be: “Never engage in image manipulation.”

Infodidactics

I use the term *infodidactics* as an umbrella term for the methods that are used for teaching various aspects of information design (Pettersson, 1998, p. 7). The huge spread among the different disciplines makes information design an interesting, but also a complex area of research and teaching. When we understand a subject matter we are able to explain phenomena and predict new phenomena. Understanding is the goal of all scientific enterprise.

Successful teaching

Cotton (1995) noted that recent work on the understanding of science had shown that some teaching leaved school children more confused than they were without the science lessons. According to Cotton this research were well documented and it were difficult for science teachers to accept the results. Dryden and Vos (1994, p.267) noted that the best systems in the world are programmed to succeed. All the world's air-lines plan to land their planes with 100% safety and security every time. A one-in-a-million failure rate would rightly be regarded as a tragedy. The world's top car companies spend a fortune to reduce their manufacturing fault-rates down from 2% to 1%. But most school systems actually expect and plan for a reject rate that would send any business bankrupt. Most current educational systems are programmed to fail a large percentage of students; in some cases up to 50%.

Dryden and Vos presented several examples of drastically improved learning. They concluded that a learning revolution would take place outside the traditional classrooms and without traditional teachers. They challenged the idea that traditional classrooms with traditional teaching would remain as the main medium of education. Dryden and Vos argued that most of the learning breakthroughs have already been made. Several breakthroughs have come from able individual teachers, from the business world, from coaching techniques, from sports psychology and from research into the human brain. Some breakthroughs have come from health programmes, and some from studies in nutrition. Many breakthroughs have come from linking businesses, communities, and schools together to re-plan the way ahead.

According to McCarthy & Higgs (2005) the scholarship of teaching requires that the teacher systematically reflects on the design, implementation and outcomes of her or his teaching in a form that can be publicly reviewed, critiqued, evaluated, and built upon by our peers (cited in Avgerinou, & Gialamas 2016, p. 149). Mayall and Robinson (2009, p. 49) argued that in-service teachers' failure to incorporate visual literacy tools in instruction stem from a lack of knowledge of the "theoretical principles and guidelines." In many places the same may be true for information design.

Practice and theory

Nordegren (2004, p. 23–24) noted that adding a theoretical view to the practice of design is to reflect on the methods, aims and the results of this practice. In order to perform sound reflections, and do a qualified reflection, we need concepts both to structure our thoughts and also to describe them verbally. In order to be able to do that we need to engage in discussions and meet with other researchers who are interested in working on the same or in similar research areas and issues.

In practical disciplines students need to develop practical experience and vocationally oriented craftsmanship and skills. They need to work with practical exercises and learn how to execute different tasks in the best economical, practical and safe way. In theoretical disciplines students need to develop their theoretical skills. They need to work with theoretical assignments, and exercise their analytical and logical skills. When studying a *combined discipline* it is important for the students involved to work with realistic and true problems. It may be a good idea to use problem-oriented learning methods, with true problems, real “information providers,” and real “information interpreters” that really need the information. This method also provides realistic experience with budget and time limits.

Around the world academic programs in information design vary according to emphasis placed by faculty on areas that contribute to the overall program. Programs are both intra-disciplinary within art and design, and interdisciplinary, based on specific goals and objectives of the programs.

A pedagogical model

This section presents the pedagogical model that I have used in several information design classes, in traditional teaching as well as in distance classes with e-learning and Internet. There have been very positive responses from the students. However, since people are different it should be noted that this pedagogical model does not work for all students. It has not been possible to adjust the pedagogical model for students with different learning styles. Furthermore many students have

usually been highly motivated. Maybe highly motivated students will learn regardless of the system used.

This model is based on the theories of combined learning, with strong influences from areas like constructivism, learning from analysis and problem solving, and co-operative learning (Pettersson, 1997, p. 93–104). We may assume that, in many situations, several learning processes are involved while we are learning. The goal is to work with methods creating commitment, motivation and learning. The teacher becomes a supervisor and a co-worker rather than a traditional lecturer. The students' study of carefully selected literature is a solid base for discussions and understanding of the subject matter.

Students work together

Learners work together in a cooperative learning environment. Thus they support one another when they learn. Since each mind develops different symbol structures, each mind perceives reality as well as all kinds of information materials differently, although common understandings may occur.

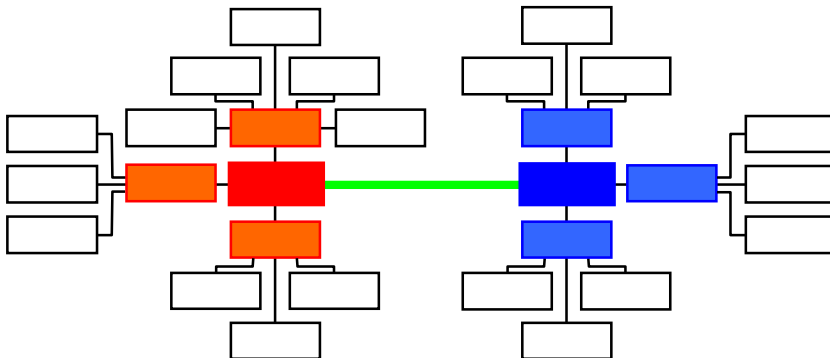
According to Bueno and Padovani (2016) collaborative work is seen as an essential means to building of knowledge in the design field, within both educational and organizational contexts. Collaborative work brings different perspectives and points of view to the realm of the problem.

Cooperative learning consists of instructional techniques that require positive interdependence between learners in order for learning to occur. In cooperative learning the dialogue is primarily between students, not with the teacher or with traditional teaching materials. However, a continuous dialogue with the teacher is desirable to secure understanding of the subject matter content. According to Kristiansen et al. (1994), the ideal learning situation includes (p. 23):

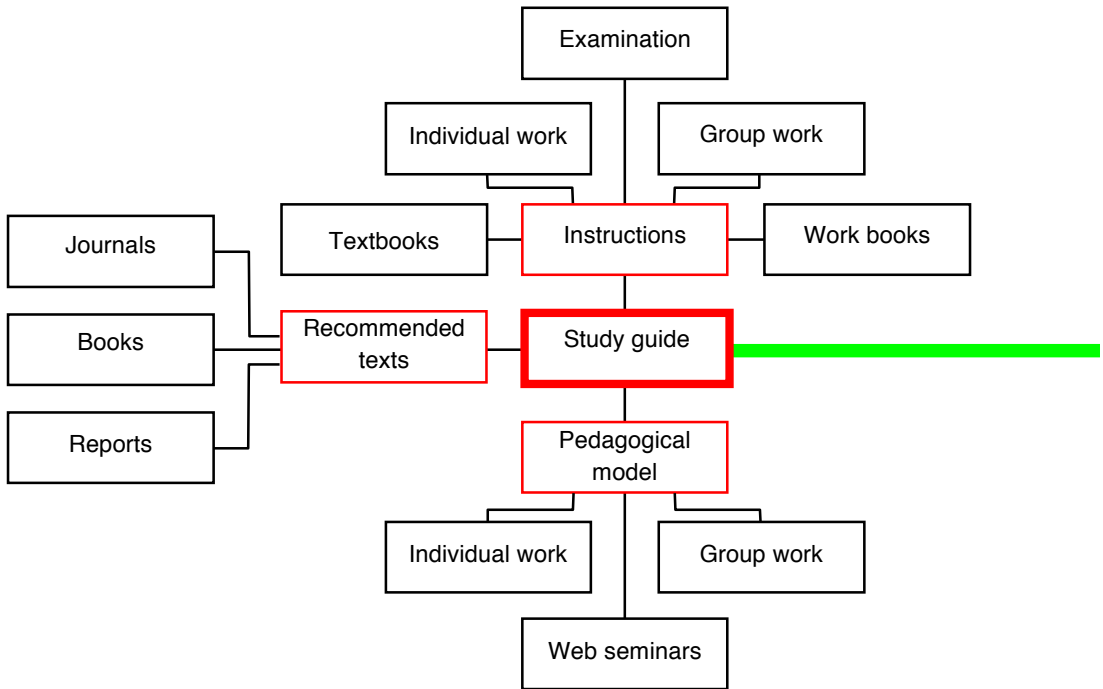
... the best possible contact with the fact about which one is to learn using the senses, the possibility of contact with people of the same ability who can create a good learning environment and with whom one can discuss, the best possible professional and pedagogical preparation with a view to learning and the opportunity for dia-

logue with helpers. And the most important; a learner who is knowledgeable about the learning process and his own role in it, who is motivated for the learning work and who believes in himself.

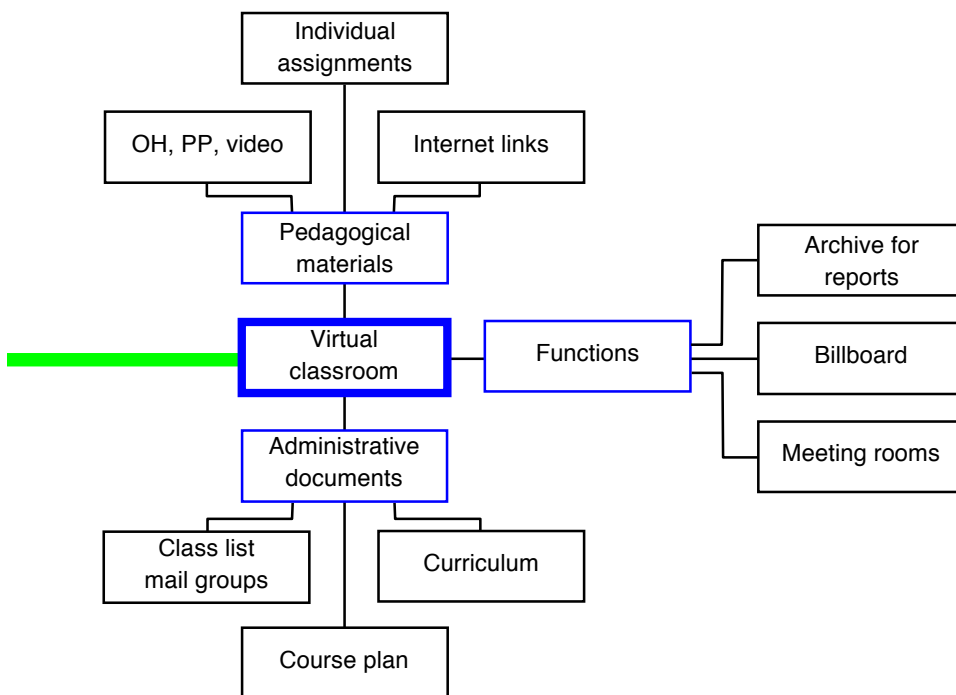
Cooperative learning is effective for developing problem solving skills in various content areas and grade levels (Johnson & Johnson, 1999). From a teaching philosophy perspective, cooperative learning is consistent with constructivism primarily due to the role of social interaction. According to some researchers learners who work together in a group co-construct more powerful understandings than individual learners can construct alone (Eggen & Kauchak, 2001). It should, however, be noted that there are different styles of learning, and cooperative learning does not work well for all students.



The “pedagogical model” for information design. Please see the following two enlargements for the details.



According to the “pedagogical model” students must have access to a comprehensive Study guide with information about the course. Students have easy access to instructions and to some of the recommended texts.



During the course all students may use a virtual classroom when they work together with group assignments. Here they can upload their own individual assignments. In this way all assignments are available for all students.

In this pedagogical model the emphasis is on the learner, not on the teacher, or on the technology. Students have access to a *Study guide* with basic information. They use a *Virtual classroom* when they work together with group assignments. Students also have individual assignments.

Forum discussions

In each module all students will reflect on the readings and participate in the asynchronous module forum discussions. Post your views in the discussion forum and respond to at least two of your peers. Communication in online environments is a common problem for students and teachers (Barbour & Unger, 2014; Ferdig et al., 2009). However, effective uses of web-based technologies allow online teachers to offer student-centred feedback.

Assignments

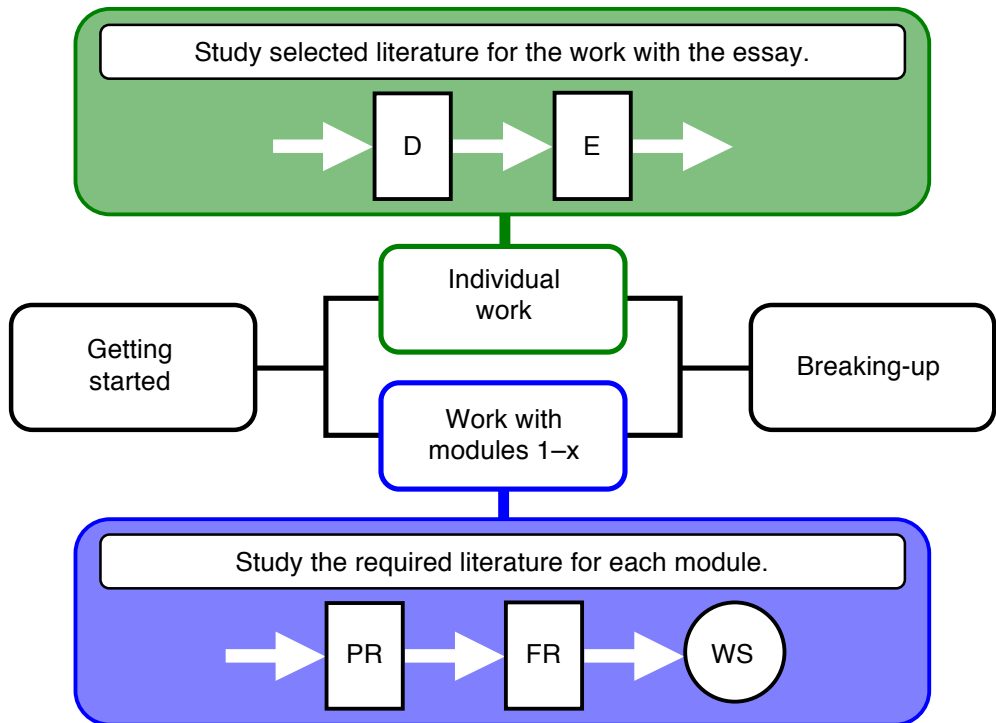
When working on group assignments students need to have continuous contacts with each other. This can happen with personal meetings or by means of electronic mail, electronic meetings in “virtual group rooms” or on an “electronic billboard.” Members of each group will decide how they want to work together.

The group assignments are concentrated on analyses, discussions and reflections of questions within each of the five modules of the course. Each group of students makes a joint presentation of the compulsory assignments within each course module. When necessary the groups may get guidance during the work with the different assignments. The module reports are examined and corrected within each group before they are uploaded in the virtual classroom. Then the module reports are automatically available for the rest of the students in the class.

Web seminars

In a virtual web seminar, a web meeting, a “webinar,” or a “chat,” the groups have the chance to have direct contacts to discuss problems related to the contents in the module. It is important that some students from each group participate in the web seminar representing the group.

According to this pedagogical model each student must take an active part in work with all group reports, all discussions and all reviews of reports from other groups, and also write an individual essay. The individual essay is important for the grading process.



Work with the individual examination paper includes selection of a topic, studies of literature, producing a draft (D), review and editing this until you have a final essay (E), which you can distribute at the end of the course. Each course module include study of the required texts, participating in the forum discussion, work with assignments, writing provisional module report (PR) and a final module report (FR), distributing this and reading the module reports from the other groups, and finally participating in the concluding web seminar for the course module (WS).

Conclusions

It may be possible to create valuable courses and programs in Information Design if we consider these conclusions:

- Students of Information Design have different backgrounds and they use different learning strategies. We should plan teaching in such a way that a large part of the students actually learn what they are expected to learn.

- Information design has a practical as well as a theoretical component. Main areas are language disciplines, art and aesthetics disciplines, information disciplines, communication disciplines, behaviour and cognition disciplines, business and law, and media production technologies.
- An information designer needs to develop skills in writing comprehensible, clear and consistent texts, in creating clear illustrations, and in creating a clear, transparent typography and layout that aids understanding and learning. The main goal in information design should always be clarity of communication.
- When students like to work together they may take part in and benefit from a cooperative learning process. In this case the teacher becomes a supervisor and a co-worker rather than a traditional lecturer.
- The context in which a specific message is presented has a major impact on the way that the message is perceived. We need to take into consideration that even when we follow all information design principles the individual “information interpreter” may conceive or misconceive the information, may use or not use it, may use or misuse it.
- Regardless of the selected medium, a well-designed information material will satisfy aesthetic, economic, ergonomic, as well as subject matter requirements. A well-designed information material makes everyday life easier for people, and it grants good credibility to the senders or sources.

This discussion concerns the design of courses and programs as well as teaching of information design. However, these findings may probably also be of value for other related areas.

Design disciplines

Nowadays we live in a world of designed artefacts. Many artefacts are concrete and others are abstract. Together with the natural world, these designs make up our reality. Margolin (1989, p. 3) remarked: “Design is all around us: It infuses every object in the material world and gives form to immaterial processes such as factory production or services.” And Lupton (2009, p. 6) noted: “Design is visible everywhere, yet it is also invisible—unnoticed and unacknowledged.” This reality includes the beautiful and the ugly, the good and the bad, and sometimes even the dangerous (Nelson & Stolterman, 2003, p. 267). Every day, we use—or struggle with—designs of every shape and size. Designs are a natural part of our lives. The information designer can provide clarity, emphasis, explanations, simplicity, and structure in data.

Several authors have provided their own definitions of the term *design*. Mijksenaar (1997, p. 14) argued that in view of *countless earlier failures*, an attempt to determine just what constitutes *design* would seem to be a precarious and impractical undertaking, and likely to throw up more questions than answers. However, as previously noted I have used the following definition of *design* in this book:

The term *design* represents two concepts: 1) Identification of a problem and the intellectual effort of an originator, manifesting itself in plans and specifications to solve the problem. 2) The outcomes of each specific design process, such as products, services, processes, and systems.

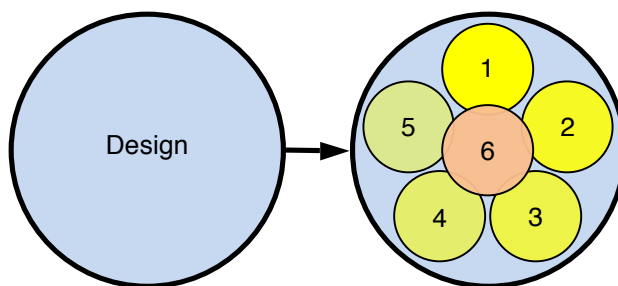
A well-designed information material makes everyday life easier for people, and at the same time it grants good credibility to the senders or sources. In this book the concept *design areas* represent many parts of human creative activities, such as architectural design, document design, exhibition design, fashion design, game design, interior design, landscape design, package design, and information design. The concept *design levels* include areas such as design of projects, design of processes, design of tools, design of products, and design of systems.

In this book the concept *design perspective*, or *execution perspective*, includes text design, image design, shape design, sound design, light design, spatial design (expo and event), and time design (the ability to deliver information when the user needs it). This concept has also been said to include views such as craft, manufacturing, technology, theory, and users. A *design team*, or an *instructional team*, is a group of people with skills in different areas working together to solve information or instructional problems. The team may have a designer, a subject matter expert, and a producer.

Design families and design genera

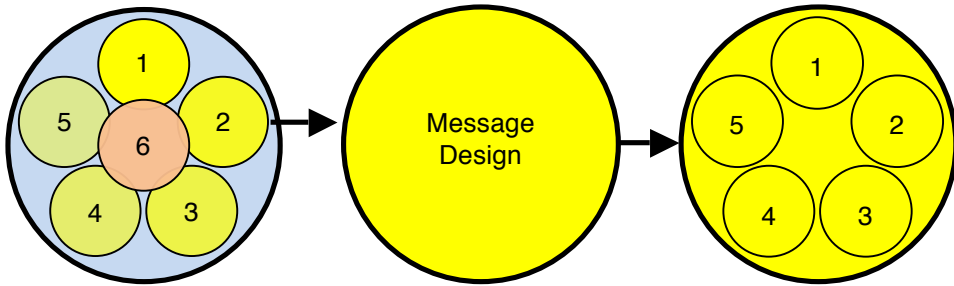
My classification of design disciplines has a “Design Order,” with six “Design families,” and five “Design genera,” each with a few “Design Species,” or “Design disciplines” (Pettersson, 2004). In my view each design discipline consists of a number of courses, with educational materials. Regardless of what we design there are common problems related to the design processes, design principles, and design tools.

In five of the design families the classification depends on the purpose with the design. We can design artefacts, different messages, performances, systems and processes, and our own environments. These design families are called artefact design, message design, performance design, systems design, and environment design. These families are hold together by the design family design philosophy.



The concept design includes six design families: 1) Artefact design, 2) Message design, 3) Performance design, 4) Systems design, 5) Environment design, and 6) Design philosophy.

The second group of design disciplines all deal with the design of *messages*. This group includes: 1) Graphic design, 2) Information design, 3) Instruction design, 4) Mass design, and 5) Persuasion design. There are different types of messages. For example, a newspaper generally uses both printed words and pictures. A television programme employs words, images and sounds.



The message design family has five design genera: 1) Graphic design, 2) Information design, 3) Instruction design, 4) Mass design, and 5) Persuasion design.

Graphic design is the art and craft of bringing a functional, aesthetic, and organized structure to different kinds of texts and illustrations. The main objective for graphic design is to provide messages that are legible for the intended audience.

Information design comprises analysis, planning, presentation and understanding of a message, its content, language and form. The main objective for information design is to provide information materials needed by the receivers in order to perform specific tasks.

Instruction design is an umbrella term for a number of areas dealing with instruction, such as educational technology, instructional design, and instructional message design. The main objective for instruction design is to provide courses, lessons and materials intended for learning.

Mass design, or “entertainment design,” is an umbrella term for mass design areas, such as mass-communication, and journalism. The main objective for mass design is to provide news, views, and entertainment.

Persuasion design is an umbrella term for advertising, planned communication, and propaganda. The main objective for persuasion design is to persuade the interpreter of the message to buy a product or a service, or to change her or his behaviour.

The concept of information design is a more widely embracing one than the concept of instruction design. From a cognitive point of view, information design is less demanding than instruction design. In instruction design the receiver usually has to learn from the message. However, in information design the receiver only has to be able to understand the message in order to use the information in a “one-time practical situation.” In many situations this will, of course, also result in learning, but here learning is usually not required. Should the need arise to once again deal with a specific practical situation the user can always read the manual again.

Design by reduction

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. A message has good *readability* when it is easy to understand.

Providing structure and *providing simplicity* are two of the *functional principles* in information design. A clear and obvious structure will facilitate perception, interpretation, understanding, learning and memory of the message content. If possible the information designer should limit the number of levels in the structure, and clearly show this in the graphic design.

The *linguistic usage* as well as the *style* should be correct to avoid distracting the readers. Style is dependent on the choice of words, consistency, expressions, picture elements, symbols, and graphic design. Abstract words, jargon, long and complex sentences, passive constructions, and stilted language may obstruct reading. Long and complex sentences require more cognitive capacity to process than short and simple sentences. It takes time to read a difficult text. We have to decode words, and maintain new concepts in working memory (Petros et al., 1990). There are a vast number of style guides and publication manuals available, and some are available on the Internet. Such docu-

ments outline standards for design and writing for a specific publication or organization.

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 further reduced to its essential form. As an example a good symbol for a sign is clear and simple. 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, and large enough to be seen. Too small or too large lettering will impair reading. The text shall also have good readability (e.g. Kirkman, 2003, 2005; Lipton, 2007; Mackiewicz, 2004; Mayer, 1993; and Wileman, 1993).

Modern graphic design

People have been designing, planning and executing information sets, information materials, and messages in all times. 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 functional and rational aesthetics that evolved in traditional graphic design over the centuries for the print media. It is now used in architecture, as well as in industrial design. The graphic designers of today have even more freedom than the monks during the Middle Ages. Nowadays it is possible to combine words and pictures at will, in effective and efficient layouts that can be adopted for all media.

Development step by step

At the beginning of the twentieth century avant-garde designers, from the modern art movement, found inspiration from efficient, functional, interesting, and very powerful new machinery in the industries. 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.

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 wrote college textbooks with design principles based on abstract painting and Gestalt psychology. György Kepes (1944), Rudolf Arnheim (1954), and Donis Dondis (1973) all had their focus on *visual perception*. For these authors design was 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).

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

In his book *Art and Visual Perception* Rudolf 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.

In his book *A Primer of Visual Literacy* Donis 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 creating 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 Friedman (1989, p. 10) the taint of commerce has relegated graphic design to the status of a “second class” discipline in the academic realm.

Present views

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

In the book “*Graphic design theory Readings from the field*” (Armstrong, 2009) twenty-four graphic designers explore 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 (p. 97) noted that digital technology fundamentally has 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. Industry-standard software and restrictive web protocols formed a new universal graphic language, while the subjective shift expressed in New Wave and post-modern 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. 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 each medium, and the corresponding technical pro-

duction. 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.

Many researchers have found that pictures should be put as close to the relevant running text as possible (e.g. Clark and Lyons, 2004; Haber and Hershenson, 1980; Mayer and Sims, 1994; Mayer, 1993; Mayer et al 1995; Moreno and Mayer, 2000; Pettersson, 1993; Schriver, 1997). 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 (Pettersson, 1993). 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).

Design principles

Many authors have offered design principles and practical instructions. The information designer provides clarity, emphasis, explanations, simplicity, and structure in data. Then it is possible for the intended audience to understand the contents in information materials.

The first century architect, author, and engineer Marcus Vitruvius Pollio presented three principles for good architecture in his book *De architectura*. A structure must exhibit the three qualities of *firmitas*, *utilitas*, *venustas*—that is, it must be solid, useful, beautiful. These are sometimes termed the *Vitruvian virtues* or the *Vitruvian Triad*. Lankow (2012) transformed these principles for design of information graphics. The first principle is *soundness*. It refers to whether the information presented is complete, correct, and valuable to the viewer. The second principle is *utility*. It refers to whether the design meets the designer’s objectives or not. The third principle is *beauty*. It refers to whether or not the design is appealing and appropriate or not.

The Italian multi-talented classical scholar Leon Battista Alberti (1404–1472) is seen as a model of the Renaissance “universal man.” He

published totally pioneering treatises on *Architecture*, on *Painting*, and on *Sculpture*. His book *Della Pittura* (On Painting), 1435, is the first modern treatise on the theory of painting. Alberti broke with the ideas of the Middle Ages and pointed to the modern era. The Italian translation became an “inspirational handbook” with detailed practical instructions for active artists. Alberti described Filippo Brunelleschi’s (1377–1446) mathematical construct of the central perspective (Toman, 1999, p. 448).

Also a number of modern authors have offered design principles in different areas of design, such as *general design* (e.g. Rowland, 1993; Shadrin, 1992; Tufte, 1983), *information design* (e.g. Lipton, 2007; Pettersson, 2002), *instructional design* (e.g. Lohr, 2003, 2010; Smith & Ragan, 2005), *instructional message design* (e.g. Fleming & Levie, 1993), and *message design* (e.g. Pettersson, 1993, 2007; Wileman, 1993). Some of these design principles are rather broad and of a general nature, while others are quite specific.

Shadrin (1992, p. 29) used the following seven design process steps, or “constants,” in his general system for *problem solving*:

1. Design activity (What is the problem?)
2. Analysis (What is the purpose and function of the design?)
3. Historical reference (How was it done before?)
4. Visual communication (How can I communicate my idea?)
5. Skills (What skills do I need for this design?)
6. Technology (How will the design or product be made?)
7. Evaluation (Is this the best solution I can come up with?)

Rowland (1993) has studied the process of design across a number of professions. According to Rowland main principles of design include the following characteristics:

- Design requires social interaction.
- Designing involves problem solving, but not all problem solving is designing.
- Designing involves technical skills and creativity and rational and intuitive thought processes.

- Designing is a goal-directed process in which the goal is to conceive and realize some new thing.
- Designing requires a balance of reason and intuition, an impetus to act, and an ability to reflect on actions taken.
- In designing, problem understanding and problem solving may be simultaneous or sequential processes.
- The design process is a learning process.
- The design process is dependent on the designer and on what he or she designs.
- The new thing that results from designing has practical utility.

Tufte (1997, p. 73) suggested using the design strategy of the *smallest effective difference*: "Make all visual distinctions as subtle, but still clear and effective."

Instructional design principles

Smith and Ragan (2005, p. 22–23) provided seven "assumptions" for instructional design. In fact these assumptions could also be regarded as "principles" for instructional design.

1. To design instruction, the designer must have a clear idea of what the learner should learn as a result of the instruction.
2. The "best" instruction is that which is effective (facilitates learners' acquisition of the identified knowledge and skills), efficient (requires the least possible amount of time necessary for learners to achieve the goals), and appealing (motivates and interests learners, encouraging them to persevere in the learning task).
3. Students may learn from many different media; a "live teacher" is not always essential for instruction.
4. There are principles of instruction that apply across all age groups and all content areas. For example, students must participate actively, interacting mentally as well as physically with material to be learned.
5. Evaluation should include the evaluation of the instruction as well as the evaluation of the learner's performance. Information from the

evaluation of instruction should be used to revise the instruction in order to make it more efficient, effective, and appealing.

6. When the purpose of assessment is to determine whether learners have achieved learning goals, the learners should be evaluated in terms of how nearly they achieve those instructional goals rather than how they “stack up” against their fellow students.
7. There should be a congruence among goals, learning activities, and assessment. Along with learner’s characteristics and learning context, learning goals should be the driving force behind decisions about activities and assessment.

These instructional design assumptions/principles will also be very useful in information design.

Quantitative information principles

According to Tufte (1983, p. 13) excellence in statistical graphics consists of complex ideas communicated with clarity, efficiency, and precision. Incorrect information in newspapers deceives many thousands of readers, and incorrectness on television may influence millions of viewers. Tufte (1983, p. 77) offered six design principles that will result in *graphical integrity* in the display of quantitative information:

1. The representation of numbers, as physically measured on the surface of the graphic itself, should be directly proportional to the numerical quantities represented.
2. Clear, detailed, and thorough labelling should be used to defeat graphical distortion and ambiguity. Write out explanations of the data on the graphic itself. Label important events in the data.
3. Show data variation, not design variation.
4. In time-series displays of money, deflated and standardized units of monetary measurements are nearly always better than nominal units.
5. The number of information-carrying (variable) dimensions depicted should not exceed the number of dimensions in the data.
6. Graphics must not quote data out of context.

These six quantitative information principles will also be very useful in information design, especially in the design of schematic illustrations.

Visual language principles

Using a large number of visual examples Malamed (2009) offers designers six principles for creating graphics and *visual language* that people may understand. These principles are:

- *Organize for perception.* (“By understanding how viewers initially analyze an image, designers can structure and organize graphic so it complements human perception.” p. 45)
- *Direct the eyes.* (“A designer or illustrator can assist this process by purposefully guiding the viewer’s eyes through the structure of a graphic.” p. 71)
- *Reduce realism.* (“There are times when the ideal expression of a message can be achieved through visual shorthand. An effective way to do this is to reduce the realistic qualities embedded in a graphic.” p. 103)
- *Make the abstract concrete.* (“Visual thinking is an integral aspect of cognition, and the visualizing of abstract concepts helps us understand the world and communicate about it.” p. 129)
- *Clarify complexity.* (Information is complex when it is voluminous, dense, and lacking in structure. p. 169)
- *Charge it up.* (The common assumption that art evokes emotion is reliably supported through brain research. 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.” p. 203)

These six visual language principles will also be very useful in information design, especially for design of all kinds of illustrations.

Functional design principles

As previously mentioned there are six functional design principles: 1) Defining the problem, 2) Providing structure, 3) Providing clarity, 4) Providing simplicity, 5) Providing emphasis, and 6) Providing unity.

Guidelines that are based on these principles will assist the information designer to design information sets that are well suited for the intended receivers. The first principle “Defining the problem” is discussed in the previous chapter *Infology theory*. The remaining five principles are discussed on the following pages.

Providing structure

A clear and obvious structure of information sets will facilitate perception, interpretation, and understanding of the information content. This will often result in learning and memory of the material. It may be a good idea to arrange the content from the most important to the least important (Lipton, 2007).

A well-structured printed information material is divided into chapters and main sections, and maybe sub-sections and sections. All these parts must work well together as a whole. A well laid-out *table of contents* gives the reader a quick and thorough idea of the whole document. A well worked-through *index*, and clear and distinct page numbering make it easier for the reader to find the information. In a document stored in a computer it is possible to use automatic *search functions*. In some documents it is possible to use *hypertext links* for quick jumps between different parts of the material, and even between different documents.

The structure of the text is very important for readability, and a structured text is much easier to read and comprehend than a text without any distinct structure. The structure should be as clear as possible. The structure of a text can be divided into internal and external textual structure.

Internal text structure is built into the text itself. It refers to the techniques used to organize, sequence, and provide an internal framework for helping readers understand the prose content. These techniques include signalling the text structure by using organization, verbal cueing, introductions, topic sentences, transitions, pointer words, and summaries. How the content is grouped may influence the readers’ first impressions of the content (Lindgaard et al., 2006).

External text structure relates to the embedded strategies that focus a learner's attention on particular parts of the text (Jonassen & Kirschener, 1982). 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. The techniques include the use of blocked text, bold text, horizontal lines to divide blocks, and italicized text. Usually printed texts vary a great deal from their original manuscripts.

Providing clarity

The *legibility* of a graphical message is determined by the technical design of texts and pictures, that is, their *clarity*. 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.

The information designer will have to make the content stand out clearly from the background (Lipton, 2007; Williams & Tollet, 1998). In general information sets should be as clear, simple, transparent, and unambiguous 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.

Legibility can be measured rather objectively. The quality of legibility 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 colours, legibility of layout, legibility of numerals, legibility of pictures, and legibility of symbols.

Providing simplicity

The subject matter in scientific and technical texts is often complex and may be difficult to grasp. But what makes a text difficult to read is not as often the subject matter itself, or the combination of grammar, spelling, and syntax, as the *style* of writing (Lipton, 2007, p. 10; Pettersson, 1989, p. 166, 268). The choice of expressions, picture elements, symbols, and words creates the style. A writing style that includes abstract words, acronyms, complex sentences, jargon, long sentences, passive constructions, and stilted language may obstruct the reading of a text. Complex and long sentences require more cognitive capacity to process mentally than short and simple sentences. It takes time to read a difficult text. We have to decode words, and maintain new concepts in working memory (Petros et al., 1990). One view is that readability refers to the “visual comfort” of the text (Mackiewicz, 2004, p. 118).

As previously noted a message has good *readability* when it is easy to understand. Nowadays readability of a message involves the reader's ability to understand the style of graphical form, the style of pictures and the style of text. The choice of picture elements, symbols, and words creates the style. The readability is determined by content and formulations, and how well the language and style are adapted to the intended readers.

There are a large number of good style guides and publication manuals available. Usually such documents outline standards for design and writing for a specific publication or organization. For example all *journalists* working at *The Economist* are given a stylebook (*The Economist*, 2003). A condensed version is available on the Internet. Many *editors* may use other well-known style guides like *The Elements of Style* (Strunk & White, 2009), *Chicago Manual of Style* (2010), *Fowler's Modern English Usage* (2004). *The Chicago Manual of Style Online* is an online style guide.

Technical writers have several sources for good advice (Kirkman, 2003, 2005). Like language itself, many style guides change with time. Therefore they are updated on a regular basis. *Researchers* in human centred areas of research may consult the *Publication Manual of the American Psychological Association* (American Psychological Associa-

tion, 2001) for valuable advice when they want to publish their results in academic journals and conference proceedings.

There is a close relationship between guidelines that are aimed at providing *simplicity* and guidelines that are aimed at *facilitating perception, processing and memory*. Simplicity in a message will result in easier and more efficient perception, processing and memory of that message. The information designer has to consider the readability of text, the readability of pictures, as well as the readability of graphical form. Providing simplicity in text, illustrations, and graphical form is probably one of the most important principles in information design. It should be a priority for the information designer to make use of the guidelines related to these areas.

Providing emphasis

The most important elements in an 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. These contrasts *attract attention*. Emphasis may be used to *direct attention*, and to *keep attention*, or dramatize certain points within information sets. Layout and typography will better show the hierarchy and the structure of the content in the information material when important parts are emphasised.

It is possible to provide emphasis in an 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. Many different elements and unexpected changes or variations out of context can cause emphasis. Colour coding is a good way to show that something is connected, or important. The information designer may also use clear contrasts, directionality, exaggerated features, humour, and isolation or motion for emphasis and enhance attention and perception (Ivory et al., Lipton, 2007).

There are a several possibilities to emphasize elements in typography. We can use boldface, colour, italics, and 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.

We should, however, never overuse any accenting techniques because if we do they may completely lose their meanings and their power to emphasize (Benson, 1985; Dwyer, 1978; Hartley et al., 1980).

Providing unity

Unity suggests an “overall togetherness” in the information material. It is more or less the opposite of 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.

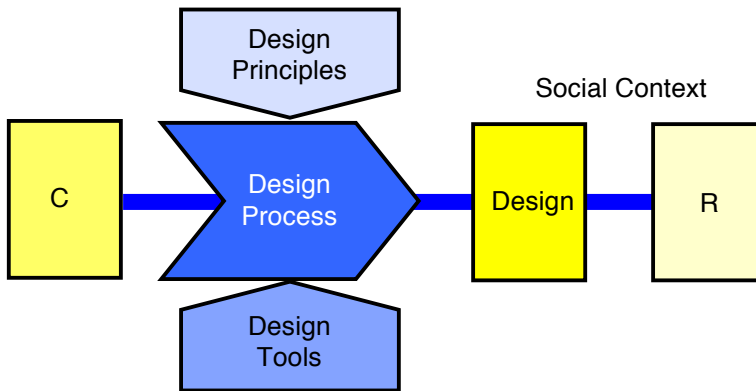
All kinds of inconsistencies in a material may confuse the receivers. It may become unnecessarily complicated for them to interpret and understand the intended content of the message. There is a close relationship between guidelines aimed at providing unity and guidelines aimed at providing harmony. To provide unity the information designer can use highlighting techniques, layout and typography, as well as style and terminology in a consistent way in each specific information set.

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.

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.

Design processes

Design processes include cognitive as well as practical activities. While a painter and a sculptor can choose any shape, a designer is limited by the function of the thing they are designing. 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 some specific information.



A design processes starts with a commission (C). The goal is to produce a final design, to be used as a master for production of a number of representations (R) or artefacts. The design process is guided by design principles and performed with the help of design tools, always in a social context.

Methodologies in design may consist of a number of compulsory steps, for example eleven steps (Roozenburg & Eekels, 1995), nine steps (Rowland, 1993), or seven steps (Bull, 1999; Shadrin, 1992). Design processes may also consist of a number of sub-processes including required activity documentation and review processes (Pettersson, 2002).

Today's design motto is very much: "function can take any form". However, designers rarely follow this motto. It is not possible to provide any firm design rules. Some say: "It Depends" (Lohr, 2010; Pettersson, 2002, 2007). In each case the information designer must be

able to analyse and understand the problem, and find one-or more-practical design solutions. The only information design rule is: "Respect copyright, and other laws and regulations related to design, production, distribution and use of information sets." Design processes are guided by design principles.

Models for design processes include cognitive as well as practical activities and aspects. The (final) design represents the outcomes of each specific design process, such as processes, products, services, and systems. On a theoretical level the intention of an overall design process, including process activities, might be the same regardless of the specific design area. Steps in a design process may be called *design activities*, such as conceptual design, embodiment design, detail design, and design reviews.

There are many opinions concerning *what* designers do when they *design*. In many design disciplines people use formalized and systematic design methodologies, processes, and rules. During any design process the designer has to gradually make a number of decisions. *Design judgments* represent a key dimension in any design process. The ability to make solid design judgments is often what distinguishes a stellar designer from a mediocre one (Nelson & Stolterman, 2003, p. 181). Design judgment is not founded on any strict rules of reasoning. It is more likely often dependent on the individuals experienced consequences of previous design choices, and her or his *tacit knowledge* in the area.

Highly skilled craftspeople speak about *instrumental judgments* as the basis for "artless art" when they refer to their interaction with materials and tools of their trade (Nelson and Stolterman, 2003, p. 197). According to Platts (1997) this is the same as *competence*.

Design theories

The term *design theory* has several meanings, related to context, mental visualisation, perception, practice, and supporting sciences. Generally speaking design theory deals with:

- *Context*. If we focus on the *context* for final design, design theory deals with how the context will influence our interpretation of the

design. It may be a cultural and political context, which influences how humans understand and create meaning (Rampell, 2003).

- *Mental visualisation*. If we reflect on design as Le Corbusier did, design theory could deal with the actual mental visualisation process model (Nylander, 1999).
- *Perception*. If we focus on how a final design can be *perceived* and visualised, design theory deals with *socio-psychological phenomena*.
- *Practice*. If we approach design as *craftwork*, design theory will deal with how to organise the knowledge of design as a practise (Hooker, 1992). Design theory provides a substantial infrastructure of formal knowledge about the practice of design (Jacobson, 1999, p. 11). Design theory explains how design works, and how it can be made more effective.
- *Science of design*. Simon introduced the concept *science of design* in 1969 in order to distinguish between academic research and artistic-practical work in the design of artefacts (cited by Margolin, 2002, p. 235). According to Cross (2001) science of design is the scientific analysis of the design activities performed via scientific methods. Every design discipline has a theoretical and a practical part
- *Supporting sciences*. Design has many applications within different supporting disciplines and sciences. Therefore design is (partly) explained by several theories (Hooker, 1992).

According to Hooker (1992) it is not possible to regard a theory of design in the same sense as a theory of chemistry since design is a *practice*. However, in my opinion, we can describe a practice theoretically and we can gradually improve the description.

Some other design areas

A few other areas and disciplines will also be mentioned briefly here. The information designer might learn a lot from the activities and processes that are used in these areas.

Industrial design

Modern design emerged in response to the Industrial Revolution. Reform-minded artists and artisans tried to impart a critical sensibility to the making of media and objects (Lupton & Miller, 1999, p. 67). Design took shape as a critique of industry.

Industrial design is the use of applied art and applied science in the design of *systems for mass production of industrial products*. The design process may include generation of concepts, drafting, sketching, rendering of three-dimensional prototypes, systems for production, packaging, and distribution (Barnwell, 2011). Many areas, such as aesthetics, art, business, economics, engineering, ergonomics, functionality, manufacturing, technology, and usability influence the design process. Industrial design can overlap with engineering design.

Before the Industrial Revolution, single craftsmen carried out the manufacturing of individual items. After the introduction of large-scale machine production and the division of labour early in the 19th century, the need of skilled industrial designers started to develop. In 1901 the American architect Frank Lloyd Wright formulated the basic principles of modern industrial design. He rejected handicraft production as too expensive, and forecasted that future designers would create prototypes for machine reproduction after becoming familiar with modern techniques and modern materials. The need to improve appearances of industrial products called for a combined knowledge of costs, design, engineering, market conditions and materials. Interest in design for mass production was strengthened in 1919 when Walter Gropius founded the Bauhaus school at Weimar, in Germany.

Wildbur and Burke (1998, p. 87) noted that surprisingly few product manufacturers retain the services of graphic designers with typographic experience. Neither do they attach enough significance to the detailed considerations of the lettering that will appear on their new

products. As a result many products suffer from inappropriate letterforms.

Information experience design

Nowadays the traditional ways we access, construct, design, and interpret information are changing rapidly. We are moving from real-world wayfinding to the augmented environments and the navigation of digital systems. People receive information through multiple multi-platform information delivery sources. Royal College of Art in London offers a program in Information Experience Design (IED). Information experience design is transforming information into experiences through the pathways of experimental design, moving image design, and sound design (Triggs, 2016). Experimental design embraces cross-disciplinary practice and transforms information into experiences and strategies for future social and urban environments. Moving image design investigates moving image as a core and vital communicative force. Sound design investigates how to make sense of sound in our complex world. Information experience design includes data visualisation, exhibitions, experimental practice, and installations.

Interaction design

Interaction design (IxD) is the practice of designing interactive digital environments, products, services, and systems. The main focus is on satisfying the desires and needs of the intended users. Behaviour studies and new designs improve the possibilities for easy interaction. According to Shedroff (1999) interaction design is at once both an ancient art and a new technology. In essence interaction design is story creating and story telling. Interaction designers are responsible for understanding and specifying how a product should behave in different situations (Cooper et al., 2007, 2014). They often work together with graphical designers and industrial designers.

According to Shedroff (1999, p. 268) “information interaction design” is the intersection of three different disciplines: 1) Information design, 2) Interaction design, and 3) Sensorial design. Sensorial design

is the employment of all the disciplines, media, and techniques we use to communicate to others through our senses.

User experience design

The *user experience architect* Donald Norman coined the term *user experience*. According to Norman and Nielsen (2016) user experience encompasses all aspects of the end-user's interaction with the company, its services, and its products.

The first requirement for an exemplary user experience is to meet the exact needs of the customer, without fuss or bother. Next comes simplicity and elegance that produce products that are a joy to own, a joy to use. True user experience goes far beyond giving customers what they say they want, or providing checklist features. In order to achieve high-quality user experience in a company's offerings there must be a seamless merging of the services of multiple disciplines, including engineering, marketing, graphical and industrial design, and interface design.

User experience design is the process of enhancing user satisfaction by improving the accessibility, pleasure and usability provided in the interaction between the user and the product. It is called UX, UED, UXD, and also XD. Good usability is essential to a positive user experience. *Usability* is the extent to which specified users to achieve specified goals in a specified context can use a product.

User experience design has its roots in ergonomics and human factors. Since the late 1940s this field has focused on the interaction between human users and machines. It is addressing how users perceive all aspects of a product or service. This became an important concern for designers in the early 1990s. Kujala et al. (2011) developed a method for evaluating long-term user experience. User experience design has evolved into a multidisciplinary design branch that involves multiple technical aspects from animation and design of motion graphics to programming.

Communication disciplines

In our modern world we need to communicate in order to establish, improve and maintain contacts, to exchange information and views, and to develop our societies.

Many authors have used theoretical models to explain what communication is, and how the processes work. Several activities are involved when a message is communicated from a sender to a receiver, and received as an internalized message. These processes are guided by principles, performed with the help of tools and influenced by the cultural and social context.

In this book *communication* involve interplay between two or more persons. If communication is to be possible at all, signals in some form must be produced, transmitted, received, deciphered, and understood. Both animals and people communicate with the aid of signals. Our human communication is unique due to our advanced use of abstract language and symbols.

A *communication theory* is an attempt to explain how and why humans communicate with each other. A large number of communication theories have originated from different disciplines, including biology, philosophy, and psychology. Many communication theories are trying to explain exactly *how* one individual is able to communicate a specific message to another individual, and how these individuals can understand each other.

Some theories may focus on the broad cultural effects of communication, and their historical and ritual significances. The specific purpose of communication is important to a given communication theory. According to Wurman et al. (2001, p. 199):

Every successful communication is really an instruction in disguise—from love letters to company brochures. ... Only teachers and trainers think of themselves as instructors, yet we are all instructors every time we communicate. And, the more we think of communicating as *instructing* versus *informing*, the more satisfaction we're likely to find in the process.

At different universities courses and complete academic programs in communication studies have many names, such as Communication and media science, Communication arts, Communication sciences, Communication studies, Communication, Communications, Mass communication, Media ecology, Media studies, Rhetorical studies, and Speech communication. The different programs may include elements from many disciplines.

For courses of *Communication Studies* students at the University of Twente in Enschede, in The Netherlands (2016) have access to an open website with presentations of no less than 48 communication theories. This is a rich source for anyone who wants a better understanding of the theoretical fieldworks of communication. We can access the presentations of the theories from different indexes. One index with “*Theory clusters*” gives us direct access to the following nine clusters:

1. Interpersonal communication and relations.
2. Organizational communication.
3. Mass media.
4. Communication and information technology.
5. Communication processes.
6. Health communication.
7. Language theories and linguistics.
8. Media, culture and society.
9. Public relations, advertising, marketing and consumer behaviour.

A number of definitions of the concept *message* may be summarized as: “A message is information content conveyed from a sender to a receiver in a single context on one occasion.” Here the main components are words, visuals and forms. Some representations also have movement and sound.

Nonverbal communication describes how it is possible to convey messages without words. These systems include body language with bodily adornment, choice of clothing, eye contact, facial expression, gesture, fragrance, odour, posture, smell and more. Channels can be auditory, biochemical, electromagnetic, haptic, kinesic, olfactory, tactile (such as in Braille), and visual. Speech also contains nonverbal ele-

ments such as articulation, intonation, rhythm, stress, and tempo. Nonverbal communication is very important in many situations. Some experts claim that our body language might be far more important than the actual words in an oral presentation (e.g. Morris, 1985).

Audience reception theories

During the 1940s, 1950s and 1960s researchers in “mass-communication” believed that audiences accepted all kinds of media messages as “true statements.” Thus newspapers, radio, and television were seen as very powerful forces in society (Buckingham, 2003). Researchers saw a direct link between the content of a message and the influence on the user (De Boer & Brennecke, 2003). In mass-communication receivers were seen as anonymous, passive, and uncritical to the messages. Several communication theories may be labeled *Audience reception theories*.

Structuralism and Post-structuralism

Structuralism is a theoretical paradigm in anthropology, linguistics, literary theory, semiotics, and sociology. Structuralism theorists believed that a language was a closed, and stable system. They argued that elements of human culture must be understood in terms of their relationships to a larger structure or system.

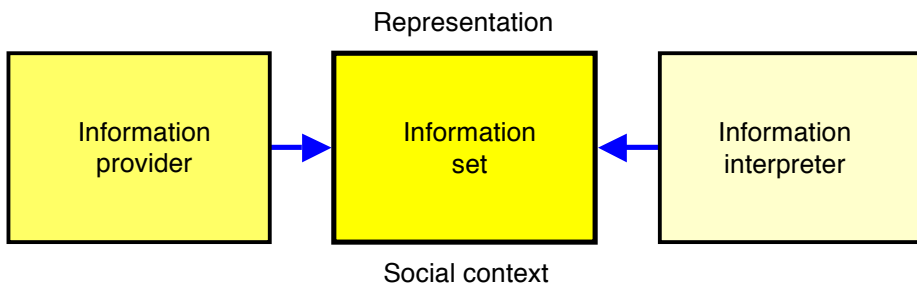
In the 1950s and 1960s structuralism theorists challenged the belief that a work of literature reflected a given reality. A text was constituted of linguistic conventions and situated among other texts. Structuralism is associated with writers such as the French anthropologist and ethnologist Claude Lévi-Strauss (1908–2009), and the Russian–American linguist and literary theorist Roman Jakobson (1896–1982). By the late 1960s structuralism gave way to post-structuralism.

Post-structuralism, or *post-structural reader theories*, developed as a negative reaction against structuralism and structural analysis. It emphasizes the instability of meaning. A sender creates a message and encodes it in a text. Later individual readers/viewers decode the message. The reader and not the writer became paramount. The sender's intended message, the text itself, and the reader/viewer all become im-

portant parts of any communication analysis. Post-structuralism is associated with writers such as the French literary theorist Roland Barthes (1915–1980) and the French philosopher Michel Foucault (1926–1984).

Encoding–Decoding model

Traditional communication models were directional and process-oriented. However, Hall (1980) developed the *encoding–decoding model*. This *audience reception theory* moved away from the view that the media had the power to directly cause a specific behaviour in individuals. The meaning of a message is created within the relationship between the message and the reader, and not by the inherent qualities of the specific communication of the message. The sender is seen as an *encoder*, constructing “meaningful” texts, such as a television program or a printed information material. The receiver is a *decoder*, and is assumed to accept, negotiate or oppose to the intended meaning in the received text. Hall emphasized this paradigm shift to earlier traditions. Audience reception theory, or reader-response theory, was widely used during the 1980s and 1990s. It was concluded that one event, and one message can each be encoded in several ways. It may be a problematic process to understand even simple messages.



An information provider makes one or more information sets available for people who need the information, information interpreters. Here the focus is on the information set.

We can regard the sender as an “information provider.” In each case the sender, or the designer, may have clear intentions and objectives. However, it is always up to the individual “information inter-

preter” to actively conceive or misconceive the information content, to use or not use it, to use or misuse it. This view is especially valid for information sets that people make available to a totally unknown audience, e.g. on the Internet and the WWW. Here it is usually not possible to know much about the people who search for, and may use the information.

Reader-response criticism is a school of literary theory that argues that a text has no meaning before a reader reads it and interprets the message in the text. The reader-response criticism can be connected to post-structural reader theories. The sender's intent, the text itself, and the reader/viewer become important parts of an analysis.

During the 1990s there was a change in reception analysis from a focus on interpretation and decoding to a greater concern with practice and use (Hagen, 1998). This development has been described as a change from decoding to viewing context (Morley, 1992).

Department stores in China frequently use Western looking manikins (visual texts) in order to advertise and display modern Chinese cloths. Ma (2004, 2006) used a structural analysis for encoded messages in manikins in public display and a post structural analysis using reception theory to analyze how customers/viewers and department store managers are related to the visual texts. Ma (2004) concluded (p. 9): “Those stereotypical images and concepts are invitations for the buyers to believe that people of this type of appearance are more affluent, better looking, and have more buying power.”

Uses and Gratifications Theory

According to the Uses and Gratifications Theory (UGT), audience members are active and goal directed. It is assumed that people actively seek out the mass media in order to satisfy their individual needs. Media users have alternate choices to satisfy their needs. Thus media have to compete with other possible sources of satisfaction. It is also assumed that a medium will be used more when the existing motives to use the medium leads to more satisfaction (McQuail, 2000).

The positivistic uses and gratifications theory focuses on the following three questions: 1) Why do people use media? 2) What do peo-

ple do with the media? 3) What are the positive and the negative consequences of individual media use?

It is clear that each person has power over his or her individual media consumption, and assumes an active role in interpreting and integrating media into his or her own life. Audiences are responsible for choosing media to meet their individual desires and needs to achieve gratification. Educators need an open mind regarding the use of media and popular culture. Certain cultural messages should not be rated better or worse than others (De Boer & Brennecke, 2003).

Unfortunately, communication does not always function as anticipated. This may depend on insufficient information content in the message, but it may also be because one or more of the different steps in the communication process fail for some reason.

Culture theories

Many researchers from many different disciplines are interested in various aspects of “culture.” There are many different perspectives, with several definitions. It is a complicated and confusing arena. For the purpose of this book I use the term “culture theories” as an umbrella term for three fields of knowledge: 1) Cultural studies, 2) Cultivation, and 3) Gender studies. These disciplines all have important contributions to information design.

(*Cultural Theory*, or *Cultural Theory of risk*, consists of empirical studies that seek to explain societal conflict over risk. *Culture theory* is a branch of comparative anthropology and semiotics.)

Cultural studies

The discipline *Cultural studies* have a critical, humanistic orientation, with a focus on popular culture (McQuail, 2000). Media influences active and heterogeneous audiences, and people will interpret messages in different ways (Hall, 1997). The audience is active and goal directed, and media compete with other sources of satisfaction.

In general media are supposed to generate profits, often through advertising. It is not always clear if messages are meant to be informative or if they are meant to be persuasive. Media messages are not neu-

tral (Considine & Haley, 1999). Power over media is a dominant cultural concept of mass communication.

Nowadays cultural meanings reside in images that were once thought simply to illustrate more culturally charged text (Davis, 2012, p. 53). We read significance in the choice of style and means of production, thus attributing subject-matter-independent meaning to both.

Ma and Semali (2003, p. 77) noted that it is often said: “digital information is transforming the way we learn, the way we communicate, even the way we think and “learn.” It is also changing the way that libraries and archives not only work, but more fundamentally the very work that they do.” The advent of the Internet has allowed people to be in contact with others whom they would not have met otherwise. Members of virtual teams who meet online can develop relationships just as close as those formed face-to-face.

Social Information

Social Information (SI) comprises studies on how citizens know their obligations, privileges, and rights. Good social information should be adapted to individual needs, capable of creating a state of preparedness in the receiver, readily accessible, readily grasped, and tailored to local requirements. Social information must be closely integrated with the activities of the respective authorities, professionally designed, and disseminated through efficient media.

Social Information Processing

Social Information Processing (SIP) occurs in large-scale networked social systems. Here groups of people organize and process information and knowledge by collective actions (Lerman, 2007). People may use computer tools like blogs, social networking, tagging systems, and translating tools, but also libraries and social networks. Wikipedia is an example of ongoing social networking.

Social Information Processing Theory

The Social Information Processing Theory (SIPT) is an interpersonal communication and media theory (Walther, 1992). This theory explains

how people interact with other people in computer-mediated online environments, typically found in Internet-based communication. Given time and opportunity to interact, individuals can form significant relationships. Here people are able to develop and manage online interpersonal relationships without any nonverbal cues and face-to-face communication (Olaniran, 2011; Olaniran, Rodrigues & Williams, 2012).

These relationships may demonstrate the same qualities as traditional face-to-face relationships, and furthermore include many interactions that would not have occurred due to factors such as economy, geography, and sociology. In face-to-face interactions, people intuitively make judgments about one another through nonverbal cues, such as body language, clothing, personal appearance, and tone of voice.

The social information processing theory contrasts other models that suggest computer-mediated communication leads to depersonalization. Cultural factors are important components of any computer-mediated communication interaction.

Culture in the Mirror theory

The Culture in the Mirror theory offers a new way of looking at a culture as an ongoing process of *making meaning* (van Heusden, 2009, 2013). According to this theory a semiotic interpretation of the development of human culture offers insight into and creates coherence between different cultural skills that people use today. The difference between stable memories and an unstable “here and now” can be dealt with through four cognitive strategies, called *basic skills*. The four basic skills are: 1) Perception, 2) Imagination and creation, 3) Conceptualization, and 4) Analysis.

Vermeersch & Vandenbroucke (2015) used the Culture in the Mirror theory in order to study aspects of visual culture in the classroom. They found that curriculum standards refer only peripherally to the use of visuals in compulsory education in Belgium.

Cultivation

Visual culture is found in every society, in private as well as in public life. Visual culture encompasses all visual aspects of each culture, ancient and modern.

Ancient examples

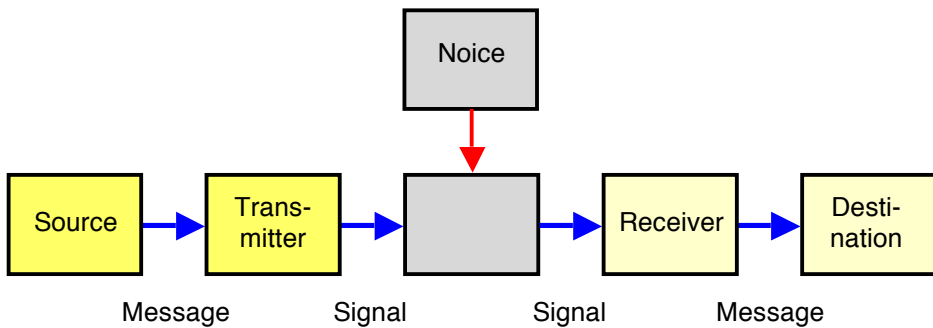
Historically, many families lived in rather close, sheltered, and tight societies. Parents and other family members had a huge influence on children and their social environments. In many cases also religion played a major role in shaping the symbolic environments in families and in societies. As an example Bronze Age people lived in a rich visual world and all knew the forms and meanings of images (Malmer, 1989, p. 15). Finds from several archaeological excavations include apparel buckles, funeral urns, jewellery, ornaments, symbols, and weapons. The images were carved, painted or sewn in different materials. The images that were carved into stone, or carved in bronze have survived best. However, materials like bark, ceramics, fabric, leather, and flat pieces of wood are only preserved under very few favourable conditions.

Much later Albertus Pictor developed his own distinct, fresh and sturdy style with bright and clear colours and distinct lines. His style and iconography is applicable to the visual culture of northern Europe in late Middle Ages in general (Åkestam, 2007).

One-way communication

A large number of authors have cited the political scientist Harold Lasswell's famous questions (1948, p. 37): "*Who says what in which channel to whom with what effect?*" Here, Laswell assumed a one-way communication, from one sender to one receiver. Lasswell argued that media messages had the same impact on any individual (Wartella and Reeves, 2003). However, the *one-way communications model* was based on a mathematical theory presented in the 1940s by the American mathematician Claude E. Shannon. He thought of information processing as the conversion of latent information into manifest information (McGonigle and Mastrian, 2011). Latent information is not yet apparent or realized. Manifest information is obvious or clearly apparent.

This model (previously called *information theory*) comprised quantitative measurement of transmitted data, especially in telecommunications systems. It had nothing to do with human communication, but it influenced the discussions and opinions. However, the model has been used frequently for discussions about human communication. A message is selected by an information source and incorporated by the transmitter into a signal, which is received by a receiver and transformed into the message reaching the destination. The signal can be influenced by noise. We can be sure that people do not derive the same information from things they read, hear, or see.



This is the Shannon and Weaver (1949) communication model.

The meaning of any language, verbal or visual, is to a large degree resident not only in words, colours, lines, and shapes but also in us. We have to learn to assign meaning to language symbols used. We have to learn the codes, and those differ in different societies and in different cultures. Wilbur Schramm (1954) used a model to show that there must also be some overlapping in the fields of experience of the sender and of the receiver for communication to take place.

Noise may intrude on various occasions and interfere with the communications process. Every perception, such as a visual sensation, is actually composed of a large number of different sub-components that are aggregated into a single holistic impression. A representation, e.g. a visual, which is to be used to convey a message, has a sender, one or more receivers, a structure, a context, and a format. The visual is

produced in a certain way with respect to various variables. Perception is different and never exactly the same twice.

Critical perspective theory

In the *Critical perspective theory*, the Marxist approach, various media are seen from an ideological perspective. This theory assumes similar powerful effects as the *One-way communication theory*. Powerful media are controlled by the ruling class, and impose a repressive ideology on the homogenous and passive audiences (McQuail, 2000).

The modern world

Nowadays we have a huge amount of digital images in television, video, and WWW. Like ancient images on bark, ceramics, and fabric the digital images will not be available for archaeological excavations in the future.

Visual culture consists of the attitudes, beliefs, conceptual realms, and values that are imbued in artefacts and performances by people that create, present, or use them. Critical reading of visual culture involves learning the skills of deconstruction to more clearly understand how cultural texts actually operate, how they signify and produce meaning, and how they influence and shape their readers. It is immensely important that we correctly interpret the images and designed objects with which we live (Barrett, 2003).

Whether we are aware of it or not visual culture is found in every arena of public and private life (Lefler, 2014). It is in our entertainment, in our neighbourhoods, in our schools, and in our places of work. It is reflected in artefacts and performances of all kinds, as well as in emerging technologies. Visual culture encompasses all of the visual arts, as well as aspects of automobiles, billboards, comics, computer graphics, fashion, landscape design, malls, packaging, performing arts, television, toys, videos, and any other man-made visual influences on our lives.

Advertising

According to Saunders (1999, p. 7) advertising of today is the world's most powerful industry. In fact, advertising is more powerful now than it has previously been at any time in history. Images often surpass words in communicating ideas, and the advertising business spends a lot of money and resources on image production (Anderson & Milbrandt, 2005).

Lefler (2014) discussed the impact of advertising in our modern visual culture. Advertising is a pedagogy that teaches individuals what they need, what they should desire, and what they should think and do to be happy, patriotic, and successful. Advertising is not just part of the dominant culture; it is the dominant culture (Twitchell, 1996). Nowadays children are often repeatedly exposed to advertising and other media messages.

Today children are often repeatedly exposed to massive advertising and other media messages in different media. Advertising is based on sound, text, and imagery that have replaced many of our old forms of communication (Green, 2000). In the early 1970's, the daily number of ads targeted at the average American was 560. By 1999, this number jumped to 3,000 ads a day. This adds up to more than one million ads per year.

No doubt we are all influenced by advertisements. According to Piette and Giroux (1998) media have an *indirect influence* on us, and media tell us what to do and what to think about. Gerbner et al. (1994) argued that years of exposure to advertising messages would influence children's symbolic environments.

Gender studies

The term *gender* generally refers to the cultural and social constructions of femininity and masculinity, and not to the biological state of being female or male (de Beauvoir, 1989). Gender studies emerged from the work by feminists, and work in sociology in the 1950s. Gender is also an important area of study within many disciplines, such as anthropology, archaeology, art history, cinema, drama, feminism, film theory, history, human development, language, law, literary theory, media studies, medicine, political science, psychology, psychoanalysis,

and sociology. In some areas gender studies are seen as a practice. In other areas representations of gender are examined from a theoretical perspective.

Gender studies are inter-disciplinary and multi-disciplinary.

In addition to intended purposes, pictures can communicate unconscious messages, values, and standpoints. The sex typing of the modern society is often reflected in mass media as well as in textbooks. Neither women nor disabled people are seen here very often, they are hidden.

Old traditions may be hard to change. In the 1970s and 1980s many researchers showed that media provided clear messages about specific gender roles in several countries. Benckert and Staberg (1988) concluded that text as well as pictures in a subtle way conveys the message that girls are not fit for studying scientific and technical subjects. One explanation to the skew distribution between sexes in textbooks could be that the textbooks actually reflect today's real society in a better way than they reflect the curriculum objectives of an equal society.

This is in fact often still the case (Bollinger, 2005; Hunter and Chick, 2005; Odén, 2005; Sosa and Kong, 2006). Contents in basic textbooks in the United States still show traditional gender roles and gender stereotyping regardless of the major changes that have appeared in public opinion. This may also be true for other countries. Men and male activities are visible also in archaeology, while prehistory women remain invisible (Arwill-Nordbladh, 2001). Thus the archaeological knowledge is "gender-marked."

Interaction theories

The discipline *Human Computer Interaction* (HCI) is an area of research and practice that emerged in the early 1980s. Initially it was a special area in computer science embracing cognitive science and human factors engineering. HCI comprises research on the design of computer systems that support people so they can carry out their activities and tasks in productive and safe ways. It has enriched every appropriated theory. A number of empirical studies consider "visual beauty" to be an important aspect. According to Carroll (2013) these theories

form three groups: 1) Theories that view human-computer interaction as information processing. 2) Theories that view interaction as the initiative of agents pursuing projects. 3) Theories that view interaction as socially and materially embedded in rich contexts.

According to Mullet and Sano (1995) all *Graphical User Interfaces* (GUI's) are communication systems. A GUI is the form of communication between users and computers that facilitates interaction (Mok, 1997). An interface is the visible piece of a system that a user sees, hears or touches (Head, 2000). The term *Solid User Interface* (SUI) was coined in Japan in order to: 1) Describe products with embedded microprocessors, such as cellular phones, photocopiers, and video cassette recorders, and 2) To distinguish them from the graphical user interfaces (GUI's) of computer applications (Wildbur and Burke, 1998, p. 98).

User-friendly *Computer-Based Training environments* (CBT's) are a challenging and critically important task for the designer (Lohr, 1999). User-friendly training environments help learners gain and maintain confidence in their ability to perform in the environment, with minimal confusion. User-unfriendly training environments do the opposite, leaving learners confused, lost, frustrated, and lacking confidence in their ability to perform satisfactorily (Flagg, 1990). In many ways human-computer interaction has similarities with interaction design and user interface design.

Fidel (2012, p. 17) discussed the general theme of *Human Information Interaction* (HII). It is the area of study that investigates how humans interact with information. HII is a multi-disciplinary area, with "fuzzy boundaries" to the various fields.

Media literacy theories

Media literacy has been defined as the “ability to access, analyze, evaluate, and communicate messages in a wide variety of forms” (Aufderheide, 1993). Media literacy resides within numerous disciplines such as anthropology, art criticism, communication, engineering, film studies, Gestalt psychology, humanities, journalism, linguistics, literacy criticism, literacy education, rhetoric, science, semantics, and sociology (Fox, 2005). In a similar way also visual literacy resides within numerous disciplines.

Medium and message

The media theorist Marshall McLuhan's famous phrase “The medium is the message” highlights the significance of the medium itself (McLuhan, 1964; McLuhan & Fiore 1967). The medium itself affects the society, and it influences how a message is perceived. Thus the medium itself, not the actual message, should be the focus of study. Western society was shaped by the alphabet. Media is powerful and an extension of man. Writing and reading allowed people to forget, and the alphabet changed the way our memory works. Education must shift from instruction to discovery, and to the recognition of the language of forms.

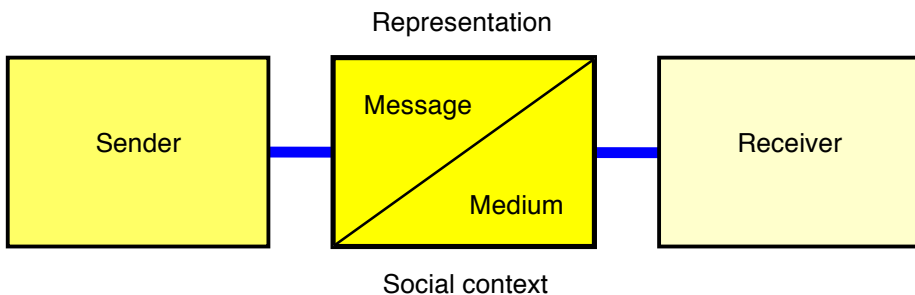
The expression “The medium is the message” has given rise to considerable confusion, and many endless discussions. In the 1980s it was often said: “The message is the medium.” Technology is the servant, and the message, the idea, is the master. However, the medium is not the message. A medium is an aid used in the transfer of a message from a sender to a receiver. The term aid is used here as a collective designation for the channel, or message carrier, and the processor/equipment required for encoding and decoding of the message.

An *information carrier* is the material that carries the information, such as electromagnetic waves, film, magnetic tape, paper, and plastic. The term *information* refers to content, message and knowledge. Information can be moved from one place to another and stored in analogue or digital form. There are different types of media. Each has its own particular properties, advantages, and disadvantages. Our existing media may be classified according to several different kinds of criteria.

The *sender* successfully transfers the *message* to the *receivers* with the help of a *medium*. A medium with a specific message constitutes a *representation*. In this book the main emphasis is on the design of information and learning materials.

In the production and distribution of a verbal and visual message, the sender will use *creative processes*, *production processes*, and *distribution processes*. Generally speaking, a sender may be an advertiser, an artist, a businessperson, a film or television producer, an instructor, a subject matter expert, a teacher, a writer, or anyone who wants to convey an intended message to one or more receivers or information providers.

The *receiver* is usually not a passive part in communication. In fact several different activities are involved when an intended message is communicated from a sender to a receiver, interpreted and understood. When a message evokes feedback to the original sender, the receiver becomes a sender, and the sender becomes a receiver. These processes are performed with the help of various tools and influenced by the social context. Communication is successful when a receiver comprehends the message a sender has wished to convey to her or him.



The sender successfully transfers the message to the receivers with the help of a medium. A medium with a specific message constitutes a representation.

It seems that designers sometimes produce materials for information and instruction mainly for their own counterparts, not for the people who actually need the contents. Many designers lack basic knowledge about communication possibilities. It is indicated here that the sender is the active part, and the receiver is a more or less passive part.

Subsequent models have incorporated an increasing number of variables but often fail, in my view, in their treatment of perception processes. Later Emmert and Donaghy (1981) expanded the Shannon and Weaver communications model to include two communicators, context and feedback. Luckily, due to education in media literacy, people are much more critical of media today (Schilder, 2013).

Media literacy outcomes

Considine and Haley (1992) argued that media literacy helps students to recognize, read, comprehend, and question ideas and information, whether conveyed to them through printed media or other media formats. News events that are shown within news broadcasts are always carefully selected, edited, designed, packaged, and presented (Considine & Haley, 1999).

Erstad (1998) discussed media literacy among children. He noted that the concept of media literacy enables us to get away from behaviourist notions about what the media do to children and move towards social-constructionist perspectives regarding children as active, competent users of television, film, video and computers. Today, curricula for media education have been developed in many countries. Education media literacy in has gained a lot of attention during the past decades.

There is a generalized understanding about what media literacy outcomes are, but they are often not defined and measured in any way (Scharrer, 2002). According to Bergsma and Carney (2008) media literacy scholars should be more precise about media literacy concepts and skills. Media literacy must be more clearly defined (Christ, 2004; Zachetti, 2011). Evaluating and explaining the effectiveness of media literacy education is one of the most overwhelming challenges for current research (Martens, 2010). Schilder (2013) reviewed "key concepts" of media literacy. She noted that several authors have presented rather similar ideas:

- All media are constructions.
- Each person interprets messages differently.
- The media have commercial interests.
- The media contain ideological and value messages.

- Each medium has its own language, style, techniques, codes, conventions, and aesthetics.
- The media have commercial implications.
- The media have social and political implications.
- Form and content are closely related in the media.

Each medium has unique aesthetics, codes and conventions. People have to learn how media are made and how they function. Each person brings her or his own experiences that affect the understanding of the representations. Individuals from different age groups, backgrounds, and cultures will understand the same message differently.

There is not much consensus over the appropriate way to measure media literacy, and it is assessed in a variety of ways. Scharrer (2002) argued that even though there is a generalized understanding about what media literacy outcomes are, they are often not explicitly defined and measured.

According to Pedelty and Kuecker (2014) media literacy help listeners, readers, and viewers to be more consciously aware of identity representation and mediation.

Agenda-setting theory

In a study on the 1968 presidential election in USA McCombs and Shaw (1972) developed the *agenda-setting theory*. Television viewers learn about “important” news. Media have an indirect influence and tell the audience what to think about (Piette & Giroux, 1998).

The agenda-setting theory describes the ability of news media to influence the salience of topics on the public agenda (McCombs & Reynolds, 2002). An audience will regard a news item that is covered frequently as more important than other news items during the same time. Mass media does not reflect reality. Mass media set the agenda for public opinion by highlighting certain issues and subjects (McCombs, 2005). However, agenda setting may be seen as a *function* of mass media, rather than a theory of mass media.

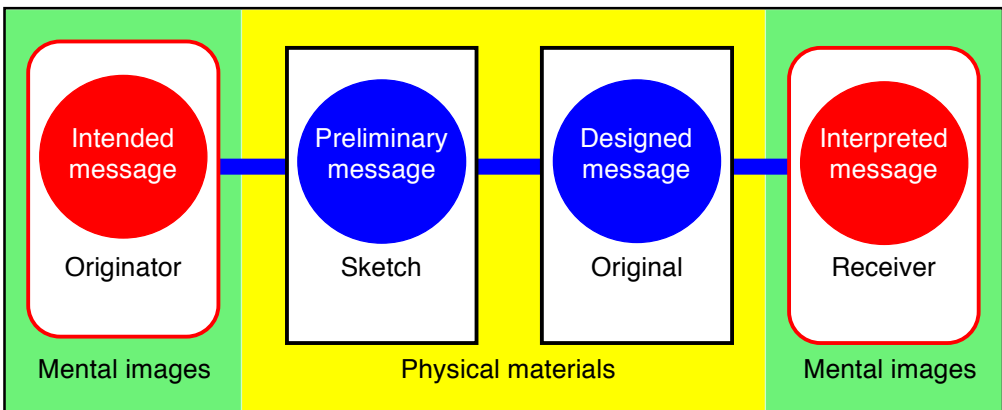
The theoretical foundations of media literacy education are related to critically viewing television and mass media research (Anderson, 1980). Most media literacy education programs do not present them-

selves as indebted to theory (Piette & Giroux, 1998; Schilder, 2013). In media literacy the importance of different theoretical approaches have changed over time (Buckingham, 2003; Hobbs, 2005; Schilder, 2013).

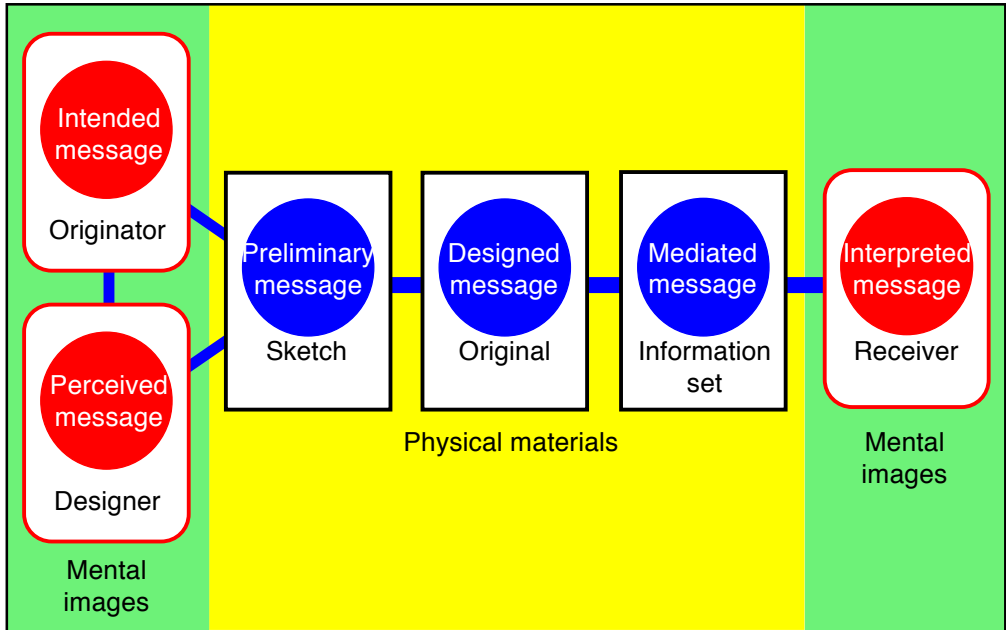
Intended messages

An originator, for example an author, a designer, an illustrator or a painter, may want to tell somebody something. Then he or she has got an *intended message* as well as one or more mental images to communicate.

By creating a number of physical outlines, or sketches, the originator is able to explain and demonstrate her or his mental images. These outlines include *preliminary messages* and they seldom reach any large audience. The mental and creative process, and the physical and practical work make it possible for an illustrator and a painter to make an original drawing or an original painting. This finished original has a *designed message*. Each person looking at the final design will create an individual *interpretation of the message*.



An originator has got an “intended message.” He or she creates a “preliminary message” and then a “designed message.” Each person looking at the final design will create her or his individual “interpreted message.”



An originator has got an “intended message.” An information designer assists the originator and creates a “perceived message” and a number of sketches. After some discussion the originator and the designer agree on a “preliminary message.” The original includes a “designed message.” After production a “mediated message” will be distributed. Each person looking at the final design will create her or his own individual “interpreted message.”

Several authors have pointed out that *form follows function*. The content of the message is more important than the actual execution of the message. Therefore, we should always begin by defining what any message is supposed to show. What is the problem we want to solve? The information in each message will have to be adapted and structured to fit the needs of the target group, the intended readers or listeners. An intended message may consist of specific data, ideas, information, some subject matter facts, or thoughts.

The purpose of an intended message may be advertising of a product or a service, entertainment, establishing a change of behaviour, information, instruction, learning, making a decision, performing an action of any kind, providing a business proposal, providing education,

training, or any combination of these and many other examples. There are many groups of receivers or information interpreters. The receivers of an intended message may be business partners, colleagues, course participants, dentists, employees, ministers, retired professors, students, teachers, teenage boys, teenage girls, veterinary surgeons, or a “general” audience—just to mention a few possible audiences. There are of course many more groups of receivers. It is obvious that a person may belong to several groups of receivers, or “target groups.” There are always individual differences among members of any group.

Representations

A representation is a medium with a specific message. Sometimes a representation is called “information set,” or “learning material,” or simply “material.”

Categories of representations

Representations can be categorized into internal and external representations (Zhang & Norman, 1994; Zhang & Pater, 2006). *Internal representations* are mental images, mental propositions, mental schemas, mental connections and networks. They must be retrieved from memory by cognitive activities. Internal representations are not further discussed here.

External representations are physical configurations such as various information sets. Kirsh (2010) noted that external representations might be manually duplicated, rearranged in different ways, and shared with other people. There are two types of external representations (Schnortz & Bannert, 2003). *Descriptive representations* include mathematical equations, spoken and written texts. *Depictive representations* include physical models, pictures, and sculptures.

Medium with message is the link between the sender/designer and the receiver/interpreter. The sender designs the message and sends it off, or makes it available. The receiver receives the message, and may try to interpret and understand it. In many ways the systems of rules that govern spoken and written language are similar. Originally, writing was a way of depicting speech, but the two coded systems have later fol-

lowed separate courses. The most tangible feature of the rules for written language is their standardisation.

In most western countries, the written language is comprehensible throughout the country and does not reflect differences in dialects. Messages including visuals are preferred by most subjects and they attract attention. Generally speaking, humans, especially their faces, are the kind of content that will get maximum attention in images. It is also known that objects and pictures of objects are remembered better than their names. Adding illustration to textual material, however, may fail to enhance attitude change. Results depend on how pictures are executed and how they are used. Association is facilitated when items are shown together.

The American industrial designer and educator Jay Doblin (1920–1989) discussed three categories of *information messages* and three types of *information content* (1980, p. 89–91). The three categories of information messages were called: 1) Verbal information messages, 2) Numerical information messages, and 3) Visual information messages. The three types of information contents were called: 1) Nominal information content (names or terms given for identification or classification), 2) Noumeral information content (conceived by reason, but not knowable through the senses), and 3) Phenomenal information content (known through experience rather than thought or intuition). Doblin combined the three forms of information messages with the three types of information content in a matrix. Thus Doblin got a structure for non-textual communications with nine cells.

1. Verbal nominal information was called *lexic*. It is lexical definitions of words.
2. Verbal noumeral information was called *logic*. It is words used for definition, classification, and reasoning.
3. Verbal phenomenal information was called *prosaic*. It is words used to describe reality, as in reports.
4. Numerical nominal information was called *numeric*. It is numbers used for identification, such as telephone numbers and license plates. These numbers are not used for any calculations.

5. Numerical noumeral information was called *mathematic*. It is numbers and symbols used for complex calculations.
6. Numerical phenomenal information was called *arithmetic*. It is the “real world” encoded into numbers by instrumentation.
7. Visual nominal information was called *ideo-grammatic*. It is “visual words” like marks, signs, and trademarks that convey a single meaning.
8. Visual noumeral information was called *diagrammatic*. It includes charts, diagrams, and graphs used to visualise processes.
9. Visual phenomenal information was called *iso-grammatic*. It is visual representation of reality such as drafts, drawings and photographs.

In this matrix the cell *iso-grammatic*, with visual phenomenal information, was divided in four levels according to an abstract to realistic scale: 1) Drafting and maps, 2) Drawings, 3) Photographs, and 4) Models. Then Doblin removed “the ladder of abstraction” from the matrix. Thus the ladder of abstraction included six levels reaching from very abstract to very realistic: 1) Marks, 2) Charts and graphs, 3) Drafting and maps, 4) Drawings, 5) Photographs, and 6) Models.

For Wileman (1993, p. 17) all kinds of representations of an object are symbols. He argued that there are three major ways to represent objects, from concrete to abstract representations. The first group, *pictorial symbols*, includes photographs and illustrations or drawings. Viewers should be able to translate a pictorial symbol to a real-world example. The second group, *graphic symbols*, has image-related graphics, concept-related graphics, and arbitrary graphics. Image-related graphics are silhouettes or profiles of the object. Concept-related graphics look like the object but have less detail than image-related graphics. Arbitrary graphics are abstract symbols for objects, constructed out of the designer’s imagination. The third group, *verbal symbols*, is divided into two sub-groups, *verbal descriptions* and *nouns or labels*. Only people who comprehend the language used to describe the objects can understand verbal symbols.

However, in my view there seems to be no major difference in “abstractness” between abstract arbitrary graphic symbols and verbal

symbols. Thus, I prefer to distinguish between two main categories of representations: 1) Figurative, and 2) Non-figurative representations. Each main category includes two groups of symbols. Figurative representations include two groups: 1) Visuals, and 2) Graphic symbols. Also non-figurative representations include two groups: 1) Verbal symbols, and 2) Non-visual and non-verbal representations.

Main categories of representations.

<i>Figurative representations</i>	<i>Non-figurative representations</i>
<p><i>1. Visuals</i> Three-dimensional images Photographs Drawings Schematic pictures</p>	<p><i>1 Verbal symbols</i> Verbal descriptions Nouns or labels Letters or characters</p>
<p><i>2. Graphic symbols</i> Pictorial symbols Abstract symbols Arbitrary symbols</p>	<p><i>2. Non-visual and non-verbal representations</i> (Sounds) Odours and scents</p>

Another view is based on how the verbal information is presented to the receivers (Pettersson, 1989, 1993). There are major differences in how we access the verbal information in various representations. Here I distinguish between three main categories of representations: 1) Lexi-visual representations, 2) Audio-visual representations, and 3) Combined representations.

We *read* the printed words in lexi-visual representations, such as books. We *listen* to the spoken words in audio-visual representations, such as radio programmes. We *read* printed words and *listen* to spoken words in combinations of lexi-visual and audio-visual representations in “combined representations,” such as interactive multimedia systems.

Verbal information in representations.

<i>Representation</i>	<i>Access activity</i>	<i>Main media</i>
Lexi-visual	Read printed words	Graphical media, computer media
Audio-visual	Listen to spoken words	Broadcast media, film media, live media, sound media, telecommunications media
Combined	Read printed words, listen to spoken words	Broadcast media, computer media, film media, live media, models and exhibitions, video media

Broadcast media include both audio and television services. Main products are radio, television, and data. Broadcast radio includes all kinds of radio, also alarm systems, and systems for military, and police. Broadcast television includes all kinds of television systems. Here data includes systems for mobile telephony.

Computer media include fields such as digital conferences, expert systems, games, hypertext, Internet, multimedia, virtual reality, and WWW. Computer media may be found as parts of the other groups, especially in the telecommunications group.

Film media may be two-dimensional or three-dimensional. Two-dimensional film media include still pictures, like slides and overhead transparencies, and moving pictures, like school and training films. Three-dimensional pictures include still pictures, like auto-stereo systems, and moving pictures, like systems with polarized light.

Graphical media are made using manual or technical methods. Drawings and paintings are examples of manually produced images. Manuscripts are examples of manually produced text. Graphical media include groups of products like books, maps, pictures, printed matter, printed music, and security print. Books include groups like children's books, comic books, fiction books, manuals, non-fiction books, periodic publications, reference books and textbooks. Different types of *packaging* often have printed pictures and text. The main task of packaging is obviously to enclose and protect the contents. Text and pictures often describe both what packaging contains and how the contents are used.

Live media are personal communications in all kinds of meetings like conferences, church ceremonies, lectures, and live music. In oral presentations the spoken word can be combined with body language, demonstrations, stills pictures, and even brief sequences employing moving images.

Models and exhibitions are multidimensional. The depth dimension makes it possible to exhibit models and real objects with a spatial relationship. Acoustic media provides some idea of the chronology. Film and video contribute with courses of events, distinct processes, and movement. Lighting, smells, tastes, and texture can also be utilised.

Sound media can be put into four groups based on the ways they can be used and the technology involved to record, store, and play music, and speech. These groups are audio tapes, firm memories, records, and sound cards, all with different characteristics.

Video media can be put into the two main groups still pictures and moving pictures. Both still pictures moving pictures can be stored in systems with firm memories, videodiscs, video sheets, and videotapes. Video media provide a high level of information content in a simple-to-understand form.

Telecommunications media are able to transmit a wide variety of data and information. These media can be put into four groups: data, pictures, sound, and text. All groups have their specific characteristics.

Objectives

The term *objectives* refers to what the sender wishes to achieve with a message, i.e. the goal(s) the sender wishes to attain. The objective of information material is usually linked to some utilitarian aspect in which the receiver is supposed to understand how something works or how to behave in a given situation in order to avoid or to resolve a problem.

A good information material has a distinct structure; it is relevant, legible and readable by the intended target group. Good information materials meet stringent demands on good economics, good contents and good linguistic and technical quality. Different information materi-

als may have multiple functions and more than one objective all at the same time.

As a result of the aforementioned properties and demands, good information materials make everyday life simpler for receivers who need the specific information and provide senders with a good economic return and good credibility. With the main objectives as the starting point, seven distinct groups of information materials are discernible. Differences between information materials are considerable within each group. There are usually clear and distinct differences between these seven groups:

1. Advertising and propaganda.
2. Informative entertainment. According to Postman (1985), television in the U.S. has made entertainment the natural form for all presentations of reality.
3. Brief messages, such as information, prohibitions, simple instructions, and warnings.
4. Administrative documentation, such as administrative messages, business documents, and working materials. Good administrative documentation and reliable routines create good conditions for satisfactory operation of various activities.
5. Factual information, such as descriptions, facts, and reports, are always more comprehensive than brief messages. Supplying information is the primary task of a large number of information materials. Factual information is presented in all media.
6. Instructions, such as directions for use, good advice, and maintenance documentation, are directions and explanatory information on appropriate procedures for achieving specific results in a safe and reliable manner. Several media are appropriate for instructions.
7. Teaching aids, such as educational films, textbooks, and video.

This classification is based on the main objectives for information materials. However, some information materials simultaneously contain more than one kind of information message. Packaging may contain both factual information and one or more instructions. Packaging could well be assigned to a category with combined objectives.

The term *text* when used in descriptions of the seven groups of information materials refers to words, pictures and shapes. The concept “informative texts” refers to the sum of “informative words, informative pictures, and informative graphical shapes.” This total is sometimes referred to as a *discourse*. In some instances, different kinds of sound, music, movement, spatial rendition, special lighting or various effects are also involved.

Production of representations

A specified number of copies may be produced from the master. In principle, the production procedure is the same in the production of graphical products, AV-media, films, video, and television programmes. In non-graphical products, sound and motion are additional important qualities. Built in proper quality controls should always be a natural part of production systems.

The sender’s production processes are influenced by production principles, and are performed with various tools for production. Production principles can be seen as a set of guidelines for production of any message. Main production principles include principles for the production of live media, sound media, film media, broadcast media, video media, models and exhibitions, graphical media, telecommunications media, and computer media.

Production processes include processes for the production of live media, sound media, film media, broadcast media, video media, models and exhibitions, graphical media, telecommunications media, and computer media. All processes should include suitable quality reviews and quality controls. Main *production tools* include: pens, pencils and other materials for manual work, computers and software to process texts and images, printers, copying machines, printing presses etc., cameras (still, film and video).

The sender’s *distribution processes* are influenced by distribution principles, and are performed with distribution tools. Distribution principles include economy, efficiency, and timing. The processes include stock keeping, marketing, advertising, selling, distribution, billing

and bookkeeping. Main distribution tools include warehouses, stores, different databases and systems like Internet and WWW.

A great many people in different occupational categories are required for transmitting a message from writers to readers: people such as text and picture editors, graphic designers, typesetters, repro technicians, printers, bookbinders, stockroom staff, salespersons, order takers, bookstore employees, librarians, buyers, and administrators.

The steps involved in publishing are time-consuming and jointly represent a major expense. About ten percent of the price of a book, not including tax, usually goes to the author. Electronic publishing could change this situation to some extent. It would reduce the distance between writers and readers. New opportunities for a dialogue could then develop in some instances.

Different types of books are affected in different ways by the information society. Books have a number of major advantages, but they also have a number of "shortcomings." One main advantage is the convenience and the size of books. A book can be used at virtually any time and place without any special equipment or preparations. Readers do not have to give a thought to connecting cords, fuses, technical standards, and voltage requirements. These aspects often complicate utilization of new media.

One of the disadvantages of books is the relatively long time it takes to produce one. Moreover, economic considerations usually comprise major restraints to factors such as illustrations. Books take up rather a lot of space and they are heavy things to transport in volume. They also tend to be in the wrong place when you need them. The lack of moving pictures and sound could also be described as disadvantages of books. An increasing number of people are working with information, and the amount of information available is increasing rapidly. The addition of new media represents increased competition for consumer time and money.

In the beginning of the 1970s, expectations were high, especially in the electronic industry and from many producers of programs. However, changes in patterns of behaviour are often slow. In 1980 more than 70 companies manufactured 195 different kinds of videocassette

recorders. There were about 50 different systems for video discs. Most of these systems soon disappeared.

From the 1980s optical media developed at a rapid pace. Compact optical discs were used as “distributed databases.” Development of Internet and Intranet has replaced many databases, and the need for many optical discs. Originally, “multimedia” referred to the use of several different media at the same time, such as a verbal presentation where the presenter uses slides and audiotape. Nowadays “multimedia” refers to the use of several representations on a computer screen, or on several screens but controlled by a computer. It may be animations, audio, graphics, still pictures, text, and video. The information is usually stored with digital technology on digital-based platforms. Systems for “virtual reality” allow users to vicariously interact within “virtual worlds.”

The initial idea with podcasting was to allow individuals to distribute their own radio shows. Williams and Tollett (2007, p. 5) wrote: “It’s like having your own radio show that everyone around the world can tune in to whenever they want, not just at the moment you happen to be recording or broadcasting.” However, the system quickly became used in a wide variety of other ways, such as distributing all kinds of multimedia files over the Internet.

The receivers

In the receiving of a verbal and visual message, the receiver will use several processes and reception tools. The receiver processes are influenced by reception principles. All these processes are influenced by prior experience in relation to age and gender. The processes are also influenced by cultural, economical, historical, political, religious, and social factors. Such experiences will influence the selection processes, the mental processes, and the response processes. The influence of these factors has a major impact on how receivers relate to messages of different kinds, and on how they construct meaning.

Receiver processes

The *intended receivers* of a message are sometimes referred to as audiences, demographic groups, information interpreters, target groups, target populations, and sometimes as users. In extreme instances, some intended groups of receivers only consist of one or two individuals. Other groups, like a *general audience*, may at the same time include millions of people. However, most audiences are somewhere in between these extremes, but certainly a lot closer to the lower end of the continuum.

The receiver's selection processes are influenced by selection principles, and are performed with search and selection tools. Selection principles include areas such as a critical view and a natural suspiciousness with respect to the sender and the purpose of the message, an understanding of the role of media in society, available time, costs, credibility, cultural factors, ease of use, individual interests, language, personal needs, reading value, and socio-economic factors.

Visuals have different purposes. The reader should always be keen to curious about any picture. Why is it there? What is the function? What is the main message? Which are the secondary meanings? Which associations will the picture raise?

Receiver processes include search for and selection of information. Search and selection tools include catalogues, databases, directories, indexes, and libraries. The receiver's mental processes are influenced by attention, perception, and learning principles, and are performed with sensory organs and the nervous system. The interpretation of an intended message will be influenced by the experiences of the individual receiver. Individuals will often interpret the same representation in different ways. These principles include areas such as attention and perception.

Other principles concern processing, such as cue information theory, dual code memory model, and schema theory. Awareness and experience of the function of media in society are also important. Main mental processes include attention, perception, cognitive processing, application, reading, intellectual development, and understanding. In

perceiving a message the receiver makes use of sensory organs and the nervous system.

The receiver's response processes are influenced by principles, and are performed with tools. Response principles include rules and guidelines, standards, and values. Response processes include application of knowledge, change of behaviour, and change of emotional status such as anger, disgust, fear, happiness, sadness, and surprise. In some situations it may be possible for the receivers to provide the sender with feedback. This feedback may be of great value for the sender when updating the information material. Response tools include body language, verbal language, and visual language. However, in many situations it is not at all possible for the individual to give any feedback to the sender.

When a message is internalized the receiver has a set of new emotions, new experiences, new feelings, new knowledge, or new understanding. The internalized message will influence the interpretation of new messages.

Finding information

The possibility of finding specific information is much higher when we really are interested in finding that information. When we browse through a newspaper, we will note those advertisements that we are interested in. In fact, we are seldom aware of the other advertisements in the paper. It is not always obvious where to look for information. Using a systematic approach can increase the possibility of finding the information we are interested in. Our previous experience can also guide us to look in the right places. We might remember that there is an interesting passage of text below a picture of a Unicorn in a big, red book on the second shelf, close to the door.

Facts and information are most useful to have at exactly the time we need it. Thus, when we have access to information may be a very important factor. A daily paper quickly becomes out-of-date. Reading a three-days-old paper is usually not very interesting. We know that a text or a picture can give rise to many individual associations. How and why we make associations are not very well known. It is almost impossible to predict how people will react in each specific situation.

Computer-based information systems have made it easier to find information, but there are also factors that can make it harder to find exact what we need. One reason is that we associate words differently, and give words different meanings depending on the context in which they appear. Furthermore, it might be impossible to know that we have found everything of interest to us after a search in hypermedia and multimedia systems. This is especially true for hypermedia systems, since the information we want might be located in many different nodes in the web. Therefore, we must scan every information item in the database to ensure that we have not missed any important information of interest. This is often impractical or impossible.

The amount of available information is growing every day. This can be described with a cone, the *information cone*, which is growing over time. When a subject matter is new, it is easy to have an overall view of all available information. The need for new ways to find will increase when the amount of information grows, and it becomes cheaper and easier to store data. Graphic design should guide the reader and help her or him to access needed information.

A good movie starts with a clear presentation of the major elements of the story. The director knows that if the dramatic conflict is not clear, the story will appear boring and meaningless to the audience. Clarity is one of the most important principles of filmmaking. The screenwriter must have a clear-cut idea of what the story is about; otherwise the resulting movie will be confusing. If the writer does not know the story, who does? A clear presentation of the subject matter is just as important in a multimedia system as in a movie. If the user does not understand right from the start what is going on, s/he can totally lose interest and/or get very confused.

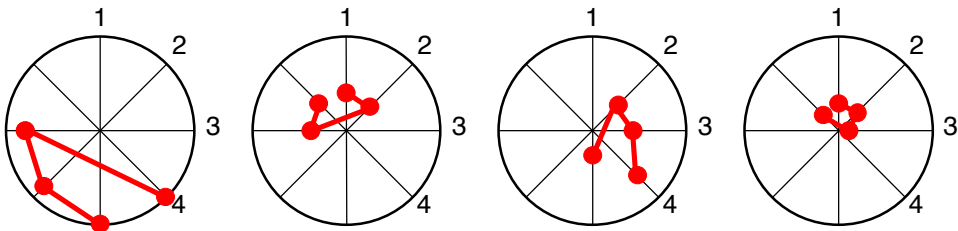
Using more than one of our senses can enhance our experience, perception and understanding of a message, and make it easier to form a conceptually complete model of a topic. A general view can make it easier to understand detailed information. Multiple perspectives are also important. Rain, for instance, is not just an abstract meteorological phenomenon, we can feel it, hear it, and taste it. Rain brings life to

plants and animals. Many media can only convey limited aspects of the total information.

Information navigation

It is possible to distinguish between different categories of variables, or “dimensions,” related to browsing, navigation, and search for information in information systems. *Browsing* is a rather random way for a human visual, search for information. *Navigation* is a combination of human visual browsing and computer-based search. We can browse through information stored in a database in a way that is similar to browsing through a book, an encyclopaedia or a newspaper. *Search* is a systematic, computer-based search for information in a database using an exactly specified concept or search question. Pettersson and Kindborg (1991) discussed four dimensions for information navigation: 1) Search, 2) Experience, 3) Structure, and 4) Sign.

Every specific representation, for example a film or a multimedia system, can be categorized by assigning a value for each dimension. If we connect the positions (dots) representing the values on each dimension, we will get an *information navigation diagram*, which shows the characteristics for that particular medium or representation.



Here are four examples of information navigation diagrams for: 1) A bibliographic database, 2) An interactive videodisc, 3) A hypermedia system, and 4) A traditional newspaper.

Search dimension

The *search dimension* is a continuum from the terminal point “regulated and restricted search” to “unregulated and flexible search.” It is based on man-machine interaction and restricted by computer software, systems design, and technology. Classical bibliographic databases

require the use of exactly stated search strings. A search string may be the name of author, the title of book, the name of publisher, or an address. Examples of hybrid systems are digital encyclopaedias, hypertext systems, daily papers, and video programs. Medical expert systems for diagnosis of diseases are found at the other end of this continuum. It is usually possible to search for information with great flexibility in expert systems.

Experience dimension

The *experience dimension* is a continuum from the terminal point “directed and intended experience” to a “free and associative experience and perception.” It is based on the functions of human perception and our possibilities to experience the contents of the actual message. A movie is presented from the beginning all the way to the resolution at the end. In fact movies used to conclude with the text “THE END.” Thus, the search possibility is regulated and restricted. In contrast to film and television, video-systems makes it possible to freely scan forward and backwards, study pictures frame by frame, repeat interesting segments, or pass uninteresting parts. The only true, free and associative experience is caused by reality itself. All representations of reality introduce some kind of restriction on our experience. However, associative multimedia systems have the potential for creating a relatively free and associative experience.

Structure dimension

The *structure dimension* is a continuum from the terminal point “linear positions” in a defined order to “non-linear positions” in a flexible structure. It is based on the actual organization of the information. In linear media the content is organized with a beginning, a main story, and a resolution. There are several hybrids of linear and non-linear organization of information. In menu driven database systems content may be organized in hierarchic tree structures. In a hypertext system the text is organized into a web of nodes connected with links. Hypermedia and expert systems might allow for almost totally non-linear structures.

Sign dimension

The *sign dimension* is a continuum from the terminal point abstract “alphanumeric characters” to “images.” It is based on the signs used to represent the information with respect to display, search, and storage. Traditional database systems are usually based on alphanumeric characters. When we browse through a newspaper we navigate using a combination of alphanumeric information (headings and subheadings) and pictorial information. Searching for visual structures in databases is still complicated, but research in image recognition will make this kind of search more common in future systems. One example is medical information system for detection of cancer cells.

Information navigation summary

Information navigation diagrams can tell us how media are related to each other. The diagrams can be used both for analysing existing information systems, and for predicting the characteristics of new systems. In an ideal information system it is easy to browse, navigate, and search for information. Such a system should have unregulated search, associative and free experience, and make it possible to navigate in a non-linear structure. It should be possible to search using both alphanumeric characters and images.

Media consumption

Our media consumption vary considerably depending on factors like:

- Competition with new media and other activities.
- Costs.
- Cultural differences.
- Different needs of education, entertainment, and information during various periods in a person’s life.
- Different usage of the media at home, in school, and at work.
- Ease of use.
- Individual interests.
- Socioeconomic factors.
- Technical developments.

In addition to Internet, newspapers, radio, and television, vast amounts of information are distributed in the form of advertising throwaways, posters, and social media on the WWW.

Media markets

We can hardly define one single media market. Instead there is a vast amount of specialized market segments. We need different kinds of education, entertainment, and information during various periods in life. Available equipments, customs and trade regulations, economy, geographical and political situations will influence our use of media.

A specific market segment may be considered very large for one medium but at the same time minor for another medium. Obviously, the characteristics and the economics of different media are extremely different. It may be worthwhile to produce a newsletter as an on-line database-service for a few hundred subscribers but not possible to produce a spectacular superstar movie for less than millions of viewers.

The activities needed to enhance the possible net profit per copy are different for various groups. For private media a solution may be to get more customers. For mass-market media the producers should get better margins. It might be forecasted that the information economy will take an increasing part of the total economy in the future.

Consumer and leisure markets are expanding. A key marketing concept in new media is to create products that will stimulate consumers into buying or renting the necessary hardware. The networking and organization facilities differ from country to country. Local and regional news and information services cover advertising, entertainment, guidance on local authority services, news stories, shopping, travel information, and more. Magazine-type services focus on a collection of related topics and include advertising, entertainment, and information. Key features are segmentation of the market, e.g., according to demographic or user needs. Computer games can be regarded as the leading edge in consumer displays and consumer involvement.

Education markets have a number of features that are important to communication media. One of the most important is the degree of interactivity that is offered between the teaching material and the user.

Others include the variety of media and the ability to deliver the material where and when it is required. Electronic media provide an increasingly important supporting role. Typical products and services include audio discs and tapes, authoring languages to enable teachers to prepare their own material, books with machine-readable sections, computer software, Internet sites, mixed media productions, modular materials, on-line computer-based training, video discs and tapes. In further education, distance-learning facilities are important. Programmed learning and faultfinding routines, computer-based learning, television programs linked to other facilities such as software, simulation exercises, and teleconferencing with tutors provide these.

Finance and business markets are time critical. Such services demand “real-time” communication and are available on demand. Typically these services are concerned with financial matters such as commodity trading and stock markets. Non-time-critical services include a series of alerting and browsing services similar in purpose to newsletter-type publications, but distributed over Internet and Intranets. In-house publications such as manuals are increasingly presented in electronic form, with greater interactivity and also quality of presentation.

Professional markets have restricted and selective applications and specialized subject areas. Services grow out of existing requirements in answer to specific needs and include current awareness, fast updating, information retrieval, provisions of specialist data and information. Commercial information providers, publishers, and professional organizations offer this kind of services. These services are mounted on host computers accessible via telecommunication networks, or supplied on portable machine-readable files such as firm memories and optical discs.

Changes in media consumption

Economic trends suggest that there is unlikely to be any scope for major cost rises, in addition to inflation, for the mass media. New media will have to compete with the media already in existence. Now people all over the world are receiving far more audio-visual information than at any other time in history. And people working in audio-visual com-

munications are striving to help people communicate, educate, inform, and train.

The importance of advertising throwaways, broadcasting of radio and television, certain books, magazines, newspapers, posters, traditional AV media, and traditional letters on paper are declining. The importance of cable TV, digital multimedia, Internet, satellite TV, social media, telecom services, and WWW are increasing. In 1985 I predicted the following long-range changes in media consumption:

1. A transition from products to services.
2. An increasing degree of segmentation.
3. Increasing flexibility.
4. Increasing competition for the individual consumer's time and money.
5. Gradual disappearance of demarcations between different media.
6. Development of new media and new techniques through "hybridization."
7. Replacement of the different systems currently available by one international, integrated digital telecommunications system.
8. Development of a single world standard for TV.
9. Increasing copyright problems.

Most of these changes have occurred. Before introducing new media, it might be a good idea to consider various viewpoints from users, producers, originators, and society.

Information disciplines

In the *Information Age*, *Computer Age*, *Digital Age*, or *New Media Age* we have an increasing need for information, and we are bombarded with information via the media, at home, in school, at work, and in society in general (Castells, 2009a, 2009b, 2010). It is rather hard to avoid information and it may be just as hard to obtain the information that we really need in order to do something. A professional information designer has competence to transform complex, unorganised, unstructured collections of data into high-quality information and present practical applications.

There are a number of definitions of the concept *information*. As previously noted, in this book the term *information* refers to the result of manipulating, organizing and processing data in a way that adds to the knowledge of the person receiving it (Simlinger, 2007, p. 8)

The verb *inform* means “to supply or convey information or to provide knowledge of something and is therefore a unidirectional process, e.g. from one person to another.”

From a terminological point of view the concept *information* may be placed somewhere between the concepts *data* and *knowledge*. The three terms *data*, *information* and *knowledge* are frequently used for overlapping concepts. These concepts are ambiguously defined in the subject matter literature. It is not at all easy to draw any strict borderlines between these three concepts.

Data are collections of facts. Data may consist of numbers, words, or visuals, often stored in lists and tables, in computer systems or on paper. Collections of data are often rather complex, unorganised, unstructured and hard to understand. The information designer has the ability to organise, structure and present data as *meaningful information* in a chart, in a table, in a text or on a map.

Information is a richly varied concept covering many important disciplines and areas of knowledge. Most people are involved with communications and communications systems in one way or another. Some of these systems have soft, human or linguistic dimensions, whereas others possess hard, technological dimensions. Some subject

fields have been well established for many years. Others are new. These fields can be regarded as independent scientific disciplines. In several instances, there is some overlapping because certain sub-issues may be addressed at the same time in different disciplines, even if the approaches may vary considerably.

Information architecture

In its broadest sense information architecture (IA) is “the structural design of shared information environments” (Information Architecture Institute, 2013, p. 1). To some degree information architecture originated in library science. Information architecture involves the structural design of systems for organization of data to help people to *find*, *navigate*, and *manage* information in complex systems. This emerging discipline is focused on combining principles of architecture and human computer design in order to support structural matters and usability. Information architecture includes databases, design of websites, Internet, intranets, library systems, online communities, and user interface design.

Information architecture is the intersection of the information content, the context of use, and the intended users (Morville & Rosenfeld, 2006; Wodtke, 2009). The organization structure is usually hierarchical, but can also have other structures (Rosenfeld & Morville, 1998).

An *information architect* needs to break information down into chunks, and create appropriate indexes and other search systems (Wurman, 1997). Effective information architects make the complex clear; they make information understandable to human beings (Wurman et al., 2001, p. 23). If the information architects succeed they are good information architects. If they fail, they are not. Now there is already a growing network of specialists in information architecture.

Information literacy

There are many definitions of information literacy. In the USA, the American Library Association (ALA, 1989) defined information literacy as follows (p. 1): “To be information-literate, a person must be able to recognize when information is needed and have the ability to locate, evaluate, and use effectively the needed information.” The same year, a National Forum on Information Literacy was established in the USA, as an umbrella group for national organizations committed to helping people become effective consumers of information. This group wants to show that literacy can no longer be considered merely to be the ability to read and memorize a base of knowledge; instead, literacy must entail the ability to acquire and evaluate the information that is needed in any situation.

Doyle (1994) defined information literacy as “the ability to access, evaluate, and use information from a variety of sources.” She created a list of characteristics of an information literate person. He or she has *information competence*, and recognizes the need for information, identifies potential sources of information, develops successful search strategies, evaluates and uses information in a qualified way, and rejects inaccurate and misleading information. Doyle concluded that as American society has shifted from an economy based on capital goods (industrial) to an economy based on services (information), there has been a corresponding shift in what is expected from American education. Knowing how to ask the right questions may be the single most important step in learning. The process that is conducted in order to find answers to the right questions leads to the point at which information becomes knowledge. Many approach the concept of information literacy holistically (Hattwig et al., 2013).

According to Malmelin (2010, p. 133) information literacy is the ability to obtain information from the media and to judge its accuracy. Mackey and Jacobson (2011) used the term *meta-literacy* in order to encompass the range of information formats that they felt should be included within the overarching concept of information literacy.

Information literacy is central to all successful learning and by extension to all successful living. All of us face an information-rich future in

which change will be one of the few constants of our life experience. The ability to adapt and fulfil our individual potentials will require us to be life-long learners and independent decision-makers.

Information competence

Doyle (1994) defined information literacy as “the ability to access, evaluate, and use information from a variety of sources.” She created a list of characteristics of an information literate person. He or she has *information competence*, and recognizes the need for information, identifies potential sources of information, develops successful search strategies, evaluates and uses information in a qualified way, and rejects inaccurate and misleading information. In accordance with Doyle an information-literate person is one who:

- Recognizes that accurate and complete information is the basis for intelligent decision-making.
- Recognizes the need for information.
- Formulates questions based on information needs.
- Identifies potential sources of information.
- Develops successful search strategies.
- Accesses sources of information including computer-based and other technologies.
- Is a competent reader, evaluates information, and determines accuracy and relevance.
- Recognizes point of view and opinion versus factual knowledge.
- Rejects inaccurate and misleading information.
- Organizes information for practical application.
- Integrates new information into an existing body of knowledge.
- Uses information in critical thinking and problem solving.

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to the point at which information becomes knowledge. Many approach the concept of information literacy holistically (Hattwig et al., 2013).

The information age demands organizations to have high *information assurance* (Cummings, 2002). Information assurance is closely related to *information security*, the process of protecting the intellectual property of an organisation (Pipkin, 2000). Good security minimises the risk of exposing important data and information to unauthorised parties (Venter and Eloff, 2003). Information security is one of the key factors to handle in the information age (Stamp, 2011). Information security is a part of *risk management*. The information age demands organizations to have high information assurance.

Information literacy and learning

According to Senn Breivik and Jones (1993), modern society has reached the point where the traditional literacies sought by liberal education are insufficient (p. 26): “Higher education is being called upon to define and develop a new learning style that fosters within students the abilities needed to be information-literate.”

Information literacy is central to all successful learning and by extension to all successful living. All of us face an information-rich future in which change will be one of the few constants of our life experience. The ability to adapt and fulfil our individual potentials will require us to be life-long learners and independent decision-makers.

In Canada the *Association for Teacher-Librarianship in Canada* (ATLC, 1995) has developed a “students’ bill of information rights.” According to this bill students in Canada should have the opportunity to:

- Master the skills needed to access information in print, non-print and electronic sources.
- Understand and master effective research processes and reporting skills.
- Develop the ability to evaluate, extract, synthesize and utilize information from a variety of sources and media;
- Utilize data and information to expand their own knowledge base.
- Explore the creative use of information.

- Develop an understanding of our Canadian cultural heritage and history, as well as cultures and histories of other societies.
- Enhance their own self-knowledge through developing a love of reading.
- Explore the values and beliefs of others by reading world literature.
- Think critically, and make decisions based on personal needs and values as well as upon factual evidence.
- Actively participate in decisions about their own learning.

Since information is a vital component in the development of critical thought and independent decision-making, access to the ever-increasing body of available information is vital to the development of students' potentials. Furthermore the Association for Teacher-Librarianship in Canada believes that all students should have the right to *access* a wide range of print, non-print and electronic learning resources at an appropriate level, *explore* materials expressing a variety of opinions and perspectives, and freely *choose* reading, viewing and listening materials for recreational and study purposes.

This kind of “students’ bill of information rights” should be extended to “all people.” In an information society, everyone should have the right to access needed information. Even if most people may be able to distinguish the sometimes-biased opinions presented by some media, not all, in fact, are able to find the objective information that they really need.

We need to learn to locate, access, evaluate, process, understand, and use information. We need to learn to handle various new situations in this age of information. Information literacy skills will be needed as a foundation for democracy and democratic societies.

As previously noted information literacy is a potential tool of empowerment for all. Many approach the concept of information literacy holistically (Hattwig et al., 2013). Information literacy programs have already encouraged shifts in the roles of teachers and learners. In an information literate environment, students engage in active, self-directed learning activities, and teachers facilitate student’s engagement through a more adventurous style of instructional delivery (Hancock, 1993).

Information quality

High-quality information is correct, credible, relevant, and easy for the intended audience to access, interpret and understand. An intended audience may range from just a few individuals up to many thousands.

Information access

Information access is one of the *administrative principles* in information design. Throughout the 1980s and 1990s, major changes occurred in the way people have produced, stored, processed, searched for and found information in modern society. Research and development produce more information content than ever before. We need to be able to access, create, define, distribute, evaluate, interpret, locate, process, produce, revise search, sort, store, understand, and use information. However, so far only limited knowledge is available about visual communications, pictures as a means of linguistic communications and the interplay between verbal and visual messages.

Information access is an area of research at the intersection of computer science, informatics, information science, information security, language technology, and library science. Regardless of the selected medium and the system for distribution the intended receivers must have easy access to data and information when they need it.

There are two quite different aspects of the concept “information access.” One aspect concerns the *external access* to information sets stored in an office and information contents stored within an information system. The other aspect concerns the *internal access* to relevant data and information contents within a specific information set. First we have to find the correct source and then we have to find the interesting content. Wurman et al. (2001, p. 8-9) argued: “Information was once a sought after and treasured commodity like a fine wine. Now, it’s regarded more like crabgrass, something to be kept at bay. ... Living in an Information Age has profoundly altered our lives, and those who fail to recognize that the rules of information design are changing will find themselves left behind.”

Obviously the information designer is not responsible for how the intended receivers store their information sets in binders and boxes on

shelves in archives, or in computer based digital systems. However, when possible, the information designer should design for easy external information access. Information sets should fit the main systems for storage. It is also important to consider aspects of information security.

It is always an advantage for multinational organisations to use international standards, such as standard page sizes. In Europe, the standard paper size is A4 (210 x 297 millimetre), whereas in the USA, US letter (216 x 279.5 millimetre) is the standard. Digital documents may be coded in accordance with the SGML standard, so that it is easy to use the information in different ways and in different formats. Nevertheless, printouts made by different printers will not be identical in appearance. Typography and layout should produce good results on standard paper. Digital documents may 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).

The information designer may also be responsible for the appearance of messages in various places, such as placements of signs in factory areas, in hospitals, sports grounds and other official buildings. Here, the information designer should provide warning signs with properties that are clear and easily noticed in bad and degraded conditions such as fog, smoke, and weak illumination (Lerner & Collins, 1983). It is also important to put warning signs close to the real hazards, and to provide the warning signs with adequate reflectance and good lighting equipments (Wogalter, 1999).

In order to provide access to relevant facts and information contents in information sets the information designer should create appropriate indexes and other search systems. In printed books and reports it is a good idea to have a list of contents, and one or more indexes. Various indexes, such as a list of illustrations, a list of artists, a list of photographers, a list of references, and a subject matter index with references to page numbers may be very useful. These indexes are easy to compile using modern word processing programs. In computer based systems it is possible to provide automatic search systems for words, for parts of texts, as well as for pictures.

Information stored in a computer system may be accessed in several different ways. The ease of use and the man-machine interaction are of vital importance. It is necessary to make the system as user friendly as possible by providing user support systems, standard function keys, and for example a possibility of full text search. Information and instructions should always be clear, consistent, concise, and simple. It seems to be very important that the user has full control of the system, i.e., with respect to reading rate and letter size when text is presented.

Information costs

As previously mentioned good legibility and good readability are probably always economically advantageous, whereas the opposite may be very costly for all parts involved. If readers do not understand the text, or if they interpret it incorrectly, it becomes very expensive.

Good design 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.

Information costs is one of the *administrative principles* in information design. The information designer must always have control over the costs for the design and production of the intended information material. It is, however, also important to consider and plan for future costs related to technical production, distribution and storage. A small mistake early in the design process may prove very costly in later process steps. The information designer will have to plan and execute continuous reviews of all costs for the material.

Engineering designers spend as much as 30% of their working time on searching and accessing information (Liu et al. 2008). The average employee spends between 55% and 65% of the day working on documents (either producing or reading them). This is a significant amount of time, representing a gigantic financial investment on the part of the employer (Stadler, 2003).

When many people have to read and also understand the information content during working hours, the cost incurred is great. It can be

expensive to produce information and learning materials, but it usually costs even more to store, find, and use it. The greater the number of individuals who must partake of certain information is, the greater the cost will be. The cost of reading is determined by the type of documents, as well as by the groups that will read them. Thus, presenting information in a suitable way offers great opportunities for saving money in any organization.

Jennings (2012) calculated the cost for reading of e-mail in large corporations. It takes, on average, about 90 seconds to read an email if it contains more than 10 sentences. And this is expensive: “If a company has 50,000 employees that receive twenty emails a day that do not contain relevant information, then the company is losing a lot of money! To be precise the company is losing 1,500,000 minutes, or 25,000 hours, of daily payroll time. If the average salary of those workers is \$30/hour, then the company loses \$750,000 every single day.” According to this calculation the cost for reading of e-mail is \$15 per person per day. This sum will add up to substantial amounts also in small organizations.

Securing quality

Securing quality is one of the *administrative principles* in information design. According to this principle the *content of the message* is more important than its context, execution, and format. Data must be correct and also relevant to the situation.

A document with good quality has a distinct structure, is legible, readable, and relevant for the intended audience. Different information sets may have multiple functions and more than one objective all at the same time. Good information sets make everyday life easier for receivers who need the specific information and provide the senders with good credibility, and a good economic return.

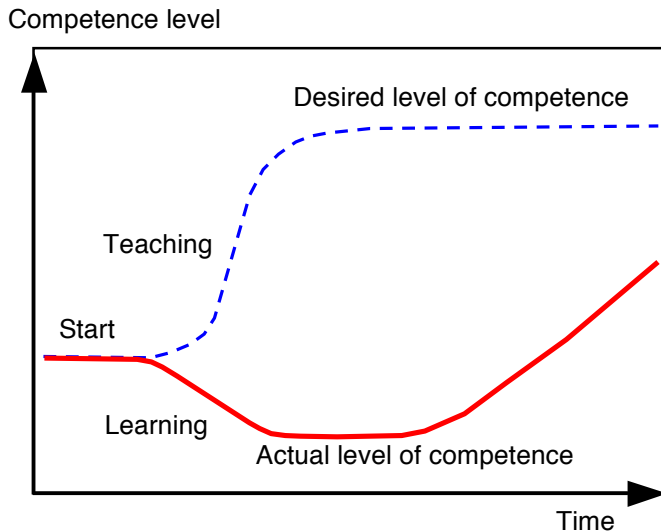
It is important to review the information material with respect to credibility, graphic design, structure, style, and terminology before technical production. The aim must always be that the learning materials and other documentation to be used for learning and training purposes receive approval. One possibility is to invite users to evaluate the

information material before the production. It is often useful to establish a system for control of the different versions of documents.

It is a good principle in the production of information and learning materials to spend enough time and effort on editing text and pictures for better comprehensibility. This will often pay back very well in less time used for reading and learning.

Poor learning materials

Training and use of “wrong” learning materials can result in a lower level of competence, greatly increase costs, and also severely delay projects (Pettersson, 2002). In one study Dawson (2012) noted that poorly designed learning materials, procedures, and other operations documents are not acceptable in industries like aviation, healthcare, or the nuclear power industry. In the aviation industry 75% of accidents were attributed to human error, and 18% of these accidents were related to maintenance (Smith, 2011).



In the worst case, training and use of substandard learning materials can result in a lower level of competence, greatly increase costs, and delay projects.

Much of what most managers and technical professionals do every day is processing of information. If information is poorly designed, they

operate inefficiently and their organizations are not as effective as they might be (Horn, 1999, p. 116).

Anderson (2012) found that the top three causes for business problems are: 1) Poor training, 2) Employees not following procedures, and 3) Poorly written procedures. Poor information design can easily be connected to the poor performance demonstrated by information receivers and interpreters. One study showed that 60% of track related accidents in the Swedish railway system were directly related to maintenance failings. Procedures provided to maintenance personnel were either poorly written or contained incorrect information (Smith, 2011).

The effort put into training and learning may actually give a *negative result*, and the learner may end up less competent than before the learning experience (Pettersson, 2002, p. 53). This may happen when he or she uses information and learning materials that:

- Is technically incorrect or irrelevant, and provides the wrong information.
- Is badly structured and therefore is hard to understand.
- Has poor legibility of text and pictures, and therefore is hard to read.
- Has poor readability of text and pictures, and therefore is hard to understand.
- Has low reading value, and is not at all worth reading for the intended audience.
- Is ungrammatical, badly spelt, and incorrectly punctuated.
- Have confusing and misleading pictures that are not at all relevant to the content of the text. Illustrations must be relevant to the prose contents.
- Has a writing style that is inconsistent and does not conform to an expected standard.
- Is not consistent throughout all its sections with respect to text, pictures, typography and layout.

Unfortunately, all of these situations are quite common today. Using the “wrong” materials means spending extra time and extra money. In a company or in any other organization the technical departments

should be responsible for ensuring that system descriptions, process descriptions, product descriptions, technical reports, course materials, and other documents to be used for learning and training purposes are technically correct and relevant to the situation.

The training and competence development departments should be responsible for ensuring that all learning materials are well-structured and understandable, as well as highly legible and readable, and have a high reading value. The production departments should be responsible for ensuring that, language and style are used in a consistent fashion in all learning materials. It is also important that the correct terminology is used, as well as layout and typography.

The result of every such review should be that a document is either approved or not approved. Documentation that is not technically correct and relevant to the situation must not be used as learning materials or course materials. Such materials should be barred. The documentation must be re-edited, and re-edited again until it receives the appropriate approval.

Benchmarking

Evans (2011) explained how the Simplification Centre, at the University of Reading, uses a system for benchmarking of everyday documents for their clarity and usability. Benchmarking is a process to establish a performance standard for organisations. The performance is compared with other organisations. At the Simplification Centre the benchmark process includes ratings of sixteen research-based criteria. The ratings are weighted to give an overall score.

Language criteria assess the use of language in the document and how easy it is for people to understand the words. These criteria are:

- *Directness*. How clear is it who's doing what?
- *Plain words*. How easy is it to understand the words?
- *Grammar and punctuation*. How does the text conform to good English?
- *Readability*. Will the intended reader be able to follow the argument of the text?

Design criteria assess the visual impact of the document and the way its design influences its usability. These criteria are:

- *Legibility*. How is the legibility of text and layout?
- *Graphic elements*. How useful are bullet lists, charts, diagrams, graphs, illustrations, tables, etc.?
- *Structure*. How is the quality of the document's organisation in relation to its function?
- *Impression*. How approachable and attractive is the overall appearance of the document?

Relationship criteria assess how far the document establishes a relationship with the users and support them in taking appropriate action. These criteria are:

- *Who from*. Is it clear who is communicating?
- *Contact*. Are there clear contact points and means of contact?
- *Audience fit*. Is the document appropriate with respect to the knowledge and skills of the intended users?
- *Tone*. Is the style and language matching the context?

Content criteria assess how well the document deliver the content. These criteria are:

- *Relevance*. How relevant is the content for the intended recipient?
- *Subject*. Is it clear what the communication is about?
- *Action*. Is it clear what action is required of the user?
- *Alignment*. How does the document comply with the intended aims and values of the organisation?

Preliminary studies of eight documents showed few problems with grammar and punctuation. However, many everyday documents had problems with readability and failed in clarity and usability. It was not always clear what the recipient needs to do, or when they need to do it. Most documents had good legibility. Evans (2011) concluded that the biggest challenge is to find a clear organising principle and use design and layout to guide users through documents.

Information science

Information science (IS), or *library and information science* (LIS), is a broad and interdisciplinary area of research and study (Ma, 1999). It comprises the study of information in general, communication processes, information management, information needs, information policy, information seeking, information structure, information technology, information theory, information users, intellectual property, scholarly communications, and visual information. Information science also comprises the study of storage of information with sub-areas like classification, indexing, cataloguing, bibliographic and other databases.

Meta-information

One special area is the study of *meta-information*, information about information. Meta-information can be abstracts, different classification systems, index tables, information about the author of a book, and keywords. Other important areas are seeking, retrieval, and dissemination of information, especially scientific and technical information. Information science also comprises various library information service activities. The main activities include administration, circulation, collections, and management of information resources, scientific communication, as well as use of information.

The task of an *informatic*, i.e., a *documentalist*, is to collect and tabulate scientific information. This information is often sought in national as well as international databases. Information can be moved from one place to another and stored in analogue or in digital form. Vickery and Vickery (1987) pointed out that information is merchandise, however quite different from other kinds of commodities. They wrote (p. 27): “Information is a peculiar commodity. When transferred from source to recipient, or from seller to buyer, it remains available to both. Unlike the sale of a material product, information transfer does not give the recipient the right of exclusive use.”

According to Fidel (2012, p. 56) numerous researchers have borrowed their theories from other fields in order to build theories in library and information science (LIS), and studies of information behav-

our. With respect to research in library and information science she concluded (p, 45):

Since LIS has one foot in theory and another in practice (and a big gap between), an LIS researcher must be clear, for herself and others, where her contribution would lie—in research, practice, or in both—in order to provide a meaningful contribution. This is particularly important in this field because it does not have the characteristics of traditional disciplines. Such disciplines already have their own schools of thought and research approaches associated with each. A researcher then needs only to identify the school to which he belongs, and his general goals and possible contributions become apparent. LIS, as a new field, has not yet developed stable research traditions; therefore, every research project has to define its purposes.

This is certainly also true for information design. In information design we constantly search for the most appropriate research methods.

A part of information science called information retrieval (IR). It comprises indexing of metadata about documents, methods and procedures for tracing of data and information stored in collections of information resources (Manning et al., 2009; Jansen and Rieh, 2010). But sometimes it is considered to be a research area of its own.

Sometimes information science, or *information studies*, excludes all connections with library science. Information studies is primarily concerned with the analysis, collection, classification, manipulation, storage, retrieval, movement, and dissemination of information (Stock & Stock, 2013).

Sense-Making

Dervin (1999) argued for a Sense-Making approach in a proposed *information design theory*. Sense-Making is a theoretic perspective with a methodological approach, a set of assumptions, communication practices, and research methods. The Sense-Making approach has been applied in a variety of contexts. It is a process by which people give mean-

ing to experience. Sense-Making has been used at various levels of analysis in both qualitative and quantitative studies.

Sense-Making, and also *Sensemaking*, has been studied since the 1970s in human-computer interaction (Russell et al., 1993), in information science (Dervin, 1992), and in organizational studies (Weick, 1995). The concept sensemaking is interdisciplinary and brings together insights from cognitive science, philosophy, and sociology. Sensemaking is seen as working concepts that makes it possible to investigate and improve the interaction between people and information technology.

Information studies

Sometimes *information science* excludes all connections with library science, and it is named *information studies*. Information studies is primarily concerned with analysis, classification, collection, dissemination, manipulation, movement, retrieval, and storage of information (Stock & Stock, 2013).

Many information studies have mainly dealt with various aspects of verbal information, such as classification, indexing, cataloguing, storing, and retrieval of text. However, the visual image has occupied a central role in human communication, and in documents, since the dawn of civilisation. Harrison (1981) noted that pictures are sources for information (p. 3):

A picture is a source of visual information. It may be a photograph of a work of art or it may be a work of art itself, but in library terms it is a piece of information to be used and evaluated as any other information available in the library. The information contained in a picture may be taken from life, of geographical features, scenery, street scenes, natural phenomena, animals, people, or activities, or a direct presentation of a work of art.

“Information studies” is a diverse and interdisciplinary field of study. Practitioners study the knowledge in organizations, the interaction between people, and the use of information systems.

The five rings

Wurman et al. (2001, p. 160–161) discussed five types of information in a model called “The five rings.” The first ring is *internal information*. It includes all the messages that move around in our own bodies. The second ring is *conversational information*. It includes all the conversations and exchanges of information that we have with people who are close to us. The third ring is called *reference information*. It includes the information we use in our own daily lives. Examples are directories, encyclopaedias, maps, and textbooks. The fourth ring is *news information*. It includes the information that is transmitted via the media. The fifth ring in this classification is called *cultural information*. It includes art, history, philosophy, and any other expression that represents our civilization.

Some other areas

A few other areas and disciplines will also be mentioned here. The information designer might learn a lot from the activities and processes that are used here.

Information economics

There are a lot of information jobs in all kinds of work places, and an increasing number of employees are working with information. Information has economic value. A branch of *microeconomic theory* is called information economics, or the economics of information (Arrow, 1996; Stiglitz, 2000).

Information may often be easy to create, but it may be hard to trust. Information is easy to distribute, but it is hard to control. Information influences important decisions and complicate many economic theories. Buying and selling information is different from buying and selling most other goods. When you sell information you still have it.

Here researchers study how information and information systems affect economic decisions and the economy. Other areas are application of information technology in the work place, business developments of information industries, geography and history of information capital, labour and capital, impact of information and communication, provi-

sion and regulation, provision of information infrastructure, and the use of computers and networks.

Information ergonomics

“Ergonomics” is a multi-disciplinary science that uses basic knowledge from economic science, engineering science, human science, and social science. The central objective of ergonomics is to improve the situation for the working person (Bubb, 2012). In real-time operational environments human operators need information to perform predefined tasks and communicate with humans and machines. Examples are head-up displays with the real view overlaid with symbols, and other digital information systems (Herczeg and Stein, 2012).

Information ergonomics comprises research and development of the ergonomic design of man-machine systems. The design of an information system should be based on studies of the user’s aims, experience, knowledge, and their ways of working. Information ergonomics includes lighting, design of characters, design of instrument panels, hypermedia information systems, operators’ consoles, signals, symbols, video display units’ and more.

Information Management

Information Management (IM) concerns a cycle of organisational activities: the acquisition of information from one or more sources, the custodianship and the distribution of that information to those who need it, and its ultimate disposition through archiving or deletion. Everywhere we look, there is a dependency on access to information and a need to process it in order to achieve an outcome (Bytheway, 2014, p. 4).

This cycle of organisational involvement with information involves a variety of stakeholders (organisations and or people). Some stakeholders are responsible for accessibility and utility of acquired information. Some are responsible for assuring the quality. Other stakeholders are responsible for safe storage and disposal. Some need the information for making decisions. Stakeholders might have rights to originate,

change, distribute or delete information according to management policies.

Information is divided in small parts, sometimes called *information elements*. These information elements are linked to objects and can be managed in computer systems. An information element may for example contain a few paragraphs of text, a list, a table, or a picture. Sometimes these elements are called *information modules*. Baya and Leifer (1996) noted that skills in information management help capture, digest, filter, and organize raw information in a way that can be retrieved and reused at a later stage of the process.

Information Technology

Throughout the 1980s, major changes occurred in the way our society accessed, processed, produced, and stored information. Monfils (1993) noted that regardless of the specific application of technology, consensus had been reached on the increasing impact of modern *Information Technology* (IT) on all aspects of our lives. The term information technology is often used for applications of computers and computer networks, as well as digital telephones and television (Proctor, 2011). The amount of information that is available to most people is seen as increasing every day. Modern development and research produce more new data and information products than ever before. Our society views the availability of, and the need for information as the basis for decision-making as continually increasing. Quite frequently, people in a variety of occupational settings find that their basic knowledge is inadequate.

Modern systems for information technology often have user interfaces based on images and symbols. These systems are intended to function in various countries, in various cultures and subcultures. Enser (1995) noted that we belong to a society experiencing technological advances that promote the importance of the visual medium for message transmission and knowledge representation. I agree with Enser that this was a paradigm shift offering both opportunities and challenges, especially for the education and information professions.

I have also foreseen two other paradigm shifts (Pettersson, 2002). In the future, we will focus on the information content rather than on the printed documents as such. We will also see a shift from emphasis on teaching to emphasis on learning. This has already happened. Malmberg (1996) pointed out that the culture industry transforms pleasure into mere entertainment and a “society of entertainment” is emerging. Here, it seems, the civic duty is to keep smiling and have fun with others. Also this has happened.

Semantic information theory

The *semantic information theory* is a part of philosophy. It refers to the information supplied by a proposition in terms of the proposition’s probability, and specifies a set of principles for measuring of information content. Information content reduces uncertainty, and it is only meaningful when it is a part of an action. We gather meaning from the empirical perspective of the use of language (Pérez-Amat García, 2009).

The *philosophy of information* is the philosophical area of research concerned with the critical investigation of the conceptual nature and basic principles of information, including its dynamics, utilization, and sciences, and the elaboration and application of information-theoretical and computational methodologies to philosophical problems (Floridi, 2004).

Language disciplines

All cultural processes may be seen as communication processes, and any system used as a means of communications between people could be regarded as a language. There may be as many as 6,000 living languages (Gunnemark and Kenrick, 1985). While linguistic scientists distinguish between spoken and written language, graphic designers distinguish between verbal and pictorial language. From a design point of view, written, printed, or displayed texts, or verbal graphic language are important components of visible language, or visual language.

However, if the linguistic representation (e.g., the medium and its content) is placed at the forefront, another approach is natural. Linguistic differentiation may be based on the form of the messages: words, sounds, images, and other forms. Thus verbal language has spoken (aural), written (visual), and tactile categories. Audial language comprises sound effects, music, and paralinguistic sounds (all aural). Visual language has symbols, pictures, and paralinguistic visual expressions (all visual). Other languages may be based on smell, on taste, and on touch.

Generally speaking *morphology* is the study of form and structure of anything. In linguistics morphology is the study of words in a language, how words are formed, changed, and combined.

Phonology is the study of *phonemes*, i.e., the smallest non-meaningful basic units of semantic differentiation found in spoken language, and combinations of these units. When combined, they form units with meaning. The smallest written unit that fills a semantically differentiating function is called a *grapheme*.

In linguistics *pragmatics* is the study of the causal and other relations between words and how we connect words to express ourselves correctly. In semiotics pragmatics is the study of the relation between signs and their effects on the people. The relations among signs in formal structures are studied in *syntactics*. The study of the relation between signs and the things to which they refer is called *semantics*.

The way in which good *quality of language* is defined is to some extent dependent upon the purpose of the specific text. Technical writ-

ers, for example, are often more consciously concentrated on getting results than other writers. Because technical language must be capable of effectively conveying as much information as possible to a certain group of readers, it is characterised in its ideal form by brevity, clarity and precision.

Literacy theories

Traditionally the concept of “literacy” was restricted to the ability to *read*, *write* and use *arithmetic*. The definition of traditional literacy has changed several times during the last decades.

According to Scott et al. (1998, p. 17) the International Adult Literacy Survey (IALS) defined *literacy* as “using printed and written information to function in society, to achieve one’s goals, and to develop one’s knowledge and potential.”

In 2000 United Nations Educational, Scientific and Cultural Organization (UNESCO) defined literacy in the following way: “Literacy is the ability to read and write with understanding a simple statement related to one’s daily life. It involves a continuum of reading and writing skills, and often includes also basic arithmetic skills (numeracy)” (UNESCO, 2004, p. 12).

In 2003 UNESCO proposed this definition: “Literacy is the ability to identify, understand, interpret, create, communicate and compute, using printed and written materials associated with varying contexts. Literacy involves a continuum of learning in enabling individuals to achieve their goals, to develop their knowledge and potential, and to participate fully in their community and wider society” (UNESCO, 2004, p. 13).

A person may be illiterate in many aspects, which is hard in our modern society. Hugo and Skibbe (1991) argued that the illiterates of the future might not be those who cannot read, but those who cannot see. Loveless (1992) suggested that children of the future must be literate in both “data in motion” and “images in motion.” According to Loveless the latter means being literate in the language of photography, film, video and satellite communications. Obviously, a modern defini-

tion of literacy must include much more than traditional reading and writing.

Traditional literacy is not enough anymore. Nowadays authors write about a large number of different *literacies*. A search on Google in August 2016 on the word *literacy* gave more than 91 million entries. Some literacy concepts are rather similar and most of them have been defined in many different ways. It is very hard, if at all possible, to find any consensus in the various literacy definitions. In my view a number of literacies are assigned to five main categories of literacy: 1) Literacy, 2) Musicacy, 3) Numeracy, 4) Visuacy, and 5) Electracy/mediacy. A sixth literacy category may be called “Area specific literacies.” There may be area specific literacies in all five main categories.

Literacy

Sometimes traditional literacy has been called *print literacy* (Suhor & Little, 1988), and *public literacy* (Moraitis & McCormack, 1995).

Adolescent literacy refers to the set of skills and abilities that students need in grades 4–12 to read, write, and think about the text materials they encounter. In recognition of the unique neurology and psychology of adolescence, distinct from the literacy development of younger readers or adults, the International Reading Association (IRA) has outlined seven guiding principles of literacy development (Atwell, 1998; Moore et al. 1999).

Critical literacy is an instructional approach to literacy that advocates the adoption of critical perspectives toward text. It encourages readers to actively analyze texts and it offers strategies for uncovering underlying messages. According to critical literacy the literate consumers of text should adopt a critical and questioning approach (Hagood, 2002).

Family literacy is an educational method providing parents and children with family-focused and long-term educational services. A literate family tends to be a stronger family with children more likely to be successful in school.

Post literacy or *post literacy education* is a concept used in adult and continuing education programs, especially in developing countries.

Unlike Continuing education these programs provide skills that might otherwise be provided in primary education.

The term *non-literality* refers to cognitive schemes (Bowers, 1990). Non-literality is expressed in many forms such as gestures, music, smell, sound, speech, taste, touch, visual images, and writing (Forceville, 2006). Children easily comprehend non-literal meanings that are based on features like colour, shape, and size (Clark, 1993; Seitz, 1997).

Musicacy

Music is a sophisticated language with its own logic and syntax. Music reading and writing skills are quite different from language reading and writing skills. *Musicacy*, or *musical literacy*, is the ability to understand and work with music. *Musical literacy* incorporates the ability to read music and understand how to make the notes on a page audible (through singing or playing an instrument). The term also refers to the skill of writing music for others to play (Perez, 2009). Musical literacy means the ability to read and understand the pitches, the rhythms, and the meaning of the music (Telfer, 2004). Musical symbols on the printed page reveal a great deal about the musicality of a piece. Each detail in the notation brings the music alive. Several pedagogies and have evolved to teach the skills of reading and writing music in elementary grades. Some regard musical literacy almost as equally important as aural skills. To be musically literate, a person has to be comfortable with musical expressions.

Numeracy

Numeracy is the ability to understand and work with numbers and other mathematical concepts. To be numerically literate, a person has to be comfortable with logic and reasoning. Innumeracy or numerical illiteracy refers to a lack of ability to reason with numbers. The areas economic literacy, financial literacy, and statistical literacy belong to this category.

Economic literacy is knowledge and understanding of basic economics. Economic literacy is a vital skill in the modern society, just as vital as reading literacy (Duvall, 1988).

Financial literacy, or *financial capability*, is the ability to understand finance. It refers to the set of skills and knowledge that allows an individual to make informed and effective decisions through their understanding of finances. In 2003 the Organization for Economic Cooperation and Development (OECD) started a project to improve financial education.

Statistical literacy is a term used to describe the ability to understand statistics and relationships of numerical information. It is necessary for citizens to be able to critically evaluate and understand numeric information presented in different media such as Internet, newspapers and television (Heiberger & Holland, 2004).

Visuacy

It seems that rather similar concepts have been developed in different places and at different times. The areas diagrammatic literacy, digital visual literacy, graphicacy, graphical literacy and visual literacy are all concerned with the ability to understand and work with different kinds of visual representations. The term *visuacy* is suggested here as an umbrella term for these concepts.

Diagrammatic literacy

Reading diagrams involves domain knowledge, motivation and bias, narrative, perception, as well as social consensus. Relationships between visual elements in a diagram mirror relationships between objects in the real world. So far there are no universal conventions for diagrams.

Coll, Coll, and Thakur (1994) compared graphs with tables. They found that business students performed more accurately with tables, and engineering students performed more accurately with graphs. The business students were faster and more accurate than the engineering students. However, both groups preferred tables. According to Allmendinger (1998) diagrammatic literacy is a matter of getting people to make better decisions based on fairly sophisticated graphics information. Lowe (1993) found that experts and novices apply different mental strategies when they read diagrams. The experts base their interpreta-

tions on underlying principles and domain based categories. Beginners, however, rely more on visual patterns in the diagrams.

Digital Visual literacy

Digital Visual Literacy (DVL) is the ability “both to create and understand certain types of information, in this case visual information created with a computer” (Spalter & van Dam, 2008, p. 94).

Graphicacy and graphical literacy

The two terms *graphicacy* and *graphical literacy* seem to represent quite similar concepts, both include the ability to understand and work with different kinds of graphics. People have used maps, pictures, and other types of graphics throughout the ages, since or before written verbal language. Nowadays graphics are far more readily available and widely used than ever before (Wilmot, 1999).

There are no universal conventions for graphics. Danos and Norman (2009) developed a taxonomy to be used as a research tool to gain an understanding of how the skills needed to understand and create drawings can affect students’ learning abilities and hence of the importance of design as a “third culture.”

The concept of *graphicacy* is concerned with the visual-spatial capacities people require in order to generate and interpret information in graphic information such as charts, diagrams, graphs, maps, plans, photographs and symbols. The study of geography, at school, college, and university levels, is the best way to improve and impart the skills of graphicacy (Balchin & Coleman, 1965, 1966).

Fry (1981, p.383) defined *graphical literacy* as “the ability to read and write (or draw) graphs.” Another definition includes more types of visual representations. Here graphical literacy is the ability to interpret charts, graphics, maps, and other pictorial presentations used to supplement the prose in textbooks, non-fiction trade books and newspapers (Tierney et al., 1990). To be *graphically literate*, a person has to be comfortable with symbols and graphical expressions. The content itself largely determines the nature of the graphic entities and the way they are organized.

Visual Literacy

Visual Literacy (VL) is a broad concept with bits and pieces from several areas of knowledge. Many definitions or explanations of visual literacy, visualization and understanding of pictures have been considered. Further see to the main section *Visual literacy theory* in this chapter.

Electracy/mediacy

The two terms *electracy* and *mediacy* seem to represent quite similar concepts, both include the ability to understand and work with digital media. *Electracy* describes the skills necessary to exploit the full communicative potential of new electronic media (Ulmer, 2003). *Mediacy* is a facility in interacting and working with media. As we become interconnected media consuming individuals we also have the opportunity to be active contributors. Much of it is multimedia with audio, images and text. *Electracy/mediacy* are to digital media what traditional literacy has been to print media. *Electracy* and *mediacy* include many areas like 21st century literacy, computer literacy, digital literacy, hypertext literacy, multi-literacy, multimedia literacy, multimodal literacy, new media literacy, screen literacy, and trans-literacy.

21st century literacy

The concept *21st century literacy* is the set of abilities and skills where aural, visual and digital literacy overlap. These include the ability to understand the power of images and sounds, to recognize and use that power, to manipulate and transform digital media, to distribute them pervasively, and to easily adapt them to new forms (The New Media Consortium, 2005).

Computer literacy

Computer literacy is the ability and knowledge to use computers and technology efficiently. A computer-literate person only needs to be a computer user, not a computer programmer.

Considine and Haley (1999) argued that computer literacy clearly relates both visual literacy and media literacy to the traditional con-

cepts of literacy, reading and writing. Monfils (1994) argued to be computer literate; a person needs only be a computer user, not a computer programmer. It is, however, not always easy to be a computer user. Sterner (1997) noted that users of all kinds of appliances often expect to be able to use the specific appliances without first reading any instructions for use at all. When people fail and realize that they need instructions for use they expect to be able to follow a clear text with pictures, and a good index, as well as a trouble-shooting guide. This however, is usually not at all the case. Instruction manuals may be hard to understand and they do not always meet even modest quality expectations.

As personal computers have become commonplace and more powerful, the concept of computer literacy has moved beyond basic functionality to more powerful applications under the heading of *multi-media literacy*.

Digital literacy

Digital literacy is the ability to locate, organize, read, interpret, understand and use images, sound and text in digital environments. A digitally literate person can evaluate and apply new knowledge gained from a wide range of digital sources in order to create and reproduce data and images in multiple formats through digital manipulation (Luce-Kapler, 2007; Jones-Kavalier & Flannigan, 2008; Metros, 2008).

Hypertext literacy

Hypertext literacy is a literacy made up of new and technologically altered kinds of access (ACLA, 2006). Publishing on the web has made the virtual printed word the creation of not just the select and selected few. Anyone now can easily publish a web site that reproduces the form of established publications, whether journalistic or academic, while the content can bear little to no resemblance to the kinds of publications that trained the web-writer's eye.

Multi-literacy

Multi-literacy is the ability to understand and use literacy and literate practices with a range of texts and technologies (including cell phones,

computers, the Internet, and social networking sites.) A multi-literate person is flexible and strategic and can fully participate in life as an active and informed citizen (Anstey & Bull, 2006; Borsheim et al., 2000; Merritt & Reed, 2008).

Multimedia literacy

Multimedia literacy, *new media literacy*, or *screen literacy*, is the ability to cope with the numerous media in use nowadays. Multimedia utilizes several different content forms to convey information (Alexander, 2008; Spalter & vanDam, 2008).

Multimodal literacy

Multimodal literacy is the ability to shift modes from open to closed networks (Alexander, 2008; Gee, 2007; Kress, 2003).

Trans-literacy

Trans-literacy is the ability to read, write and interact across a range of different platforms, tools and media from signing and orality through handwriting, print, TV, radio and film, to digital social networks (Thomas, 2005).

Area specific literacies

Several literacies are “area specific” and at the same time they may belong to more than one of the five main categories of literacy. Categories like advertising literacy, aesthetic literacy, agricultural literacy, cultural literacy, diaspora literacy, ecological literacy, ecoliteracy, environmental literacy, health literacy, information literacy, informational literacy, media literacy, mental health literacy, mental literacy, political literacy, promotional literacy, rhetorical literacy, scientific literacy, social literacy, technological literacy, and television literacy all belong in this category.

Advertising literacy

With respect to media education and media research advertising literacy is an analytical concept (Malmelin, 2010, p.132). From the con-

sumer point of view, advertising literacy is the individual's ability and skill of observation, recognition and understanding commercial messages. For the communicator advertising literacy provides directions for planning of advertising.

The elements of an advertising message may be graphic design, music, pictures, sounds, structure, words, and the action itself. The structure is the way the elements are combined to create an effect of a coherent message. In order to influence others, the senders must exchange information, accurately transmit their messages and intentions, and identify and understand the habits of the intended receivers. The more often a message is sent, the more familiar it becomes and the more likely it is to be remembered.

Aesthetic literacy

Aesthetic literacy refers to interpreting and understanding of advertisements as a source of aesthetic pleasure and entertainment (Malmelin, 2010, p. 134). Aesthetic literacy includes the possibility of valuing the artistry and understanding the elegance of decisions in design, execution and production.

Agricultural literacy

Agricultural literacy is a term being used to describe programs to promote the knowledge and understanding that is necessary to analyze, synthesize, and communicate basic information about agriculture to consumers, producers, and students of agriculture.

Cultural literacy

Cultural literacy is the ability to fluently participate in and understand a given culture. A culturally literate person knows the signs and symbols in a culture. This includes culturally conditioned allusions, dialectic stories, entertainment, idiomatic expressions, idioms, idiosyncrasies, jokes, names, and places. A culturally literate person is able to talk to and understand others of that culture (Gee, 2007; Hirsch Jr., 1987; Kellner, 1998; Kress, 2003).

Diaspora literacy

Diaspora literacy is the ability to understand and/or interpret the multi-layered meanings of stories, words, and other folk sayings within any given community of the African diaspora. These meanings go beyond literal or typical literary interpretation into an area of folk understanding.

Ecological literacy

Ecological literacy, or *ecoliteracy*, is the ability to understand the natural systems that make life on earth possible (Orr, 1992; Capra, 1997). An ecologically literate person understands the organization of ecological communities and ecosystems. An ecologically literate society is sustainable, without destruction of the natural environment.

Environmental literacy

Environmental literacy is essentially the capacity to perceive and interpret the relative health of environmental systems and take appropriate action to maintain, restore, or improve the health of those systems (Roth, 1992). Levels of literacy are generally assumed to exist but are not often defined. With respect to environmental literacy, Roth proposed the identification of three levels:

- Nominal, indicating ability to recognize many of the basic terms used in communicating about the environment and to provide rough, if unsophisticated, working definitions of their meanings.
- Functional, indicating a broader knowledge and understanding of the nature and interactions between human social systems and other natural systems.
- Operational, indicating progress beyond functional literacy in both the breadth and depth of understandings and skills.

These three levels of literacy; nominal, functional, and operational, could also be used in other literacies.

Health literacy

Health literacy is an individual's ability to obtain, read, understand and use healthcare information to make decisions and follow instructions for treatment. There are, however, multiple definitions of health literacy (Pleasant & McKinney 2011). Up to half of patients in the U.S. cannot understand basic healthcare information (Nutbeam, 2000; Zarcadoolas et al., 2005). Simplified information with good illustrations is needed.

Information literacy

As previously noted the American Library Association (ALA, 1989) defined information literacy as follows (p. 1): "To be information-literate, a person must be able to recognize when information is needed and have the ability to locate, evaluate, and use effectively the needed information." Further see to the main section *Information literacy* in the chapter *Information disciplines*.

Media literacy

As previously noted media literacy resides within numerous disciplines such as anthropology, art criticism, communication, engineering, film studies, Gestalt psychology, humanities, journalism, linguistics, literacy criticism, literacy education, rhetoric, science, semantics, and sociology (Fox, 2005). Further see the main section *Media literacy* in the chapter *Communication disciplines*.

Mental health literacy

Mental health literacy has been defined as knowledge and beliefs about mental disorders that aid their recognition, management or prevention. Members of the public need to have some knowledge to allow them to recognise, prevent, and seek early help for mental disorders (Jorm et al., 1997). Surveys of mental disorders in a number of countries show that people often have negative attitudes towards people with mental disorders.

Mental literacy

Mental literacy is a metaphor for the use of the brain as a super bio-computer (Buzan & Buzan, 1994).

Meta-literacy

Mackey and Jacobson (2011) used the term *meta-literacy* in order to encompass the range of information formats that they felt should be included within the overarching concept of information literacy.

Multicultural literacy

We live in multicultural societies. We often interact with people from different countries around the world, and with different experiences. Multicultural literature describes how people live in different parts of the world. It includes knowledge of cultures and languages, as well as the ways graphics, text, and sound may introduce bias into language, generalizations, perspective, stereotypes, subject matter, and visual content.

Political literacy

Political literacy is a set of abilities necessary for citizens to participate in a society's government. It includes an understanding of how government works and of the important issues facing society, as well as the critical thinking skills to evaluate different points of view.

Promotional literacy

Promotional literacy is the aspect of advertising literacy that helps consumers weigh and evaluate the commercial forms, functions and objectives of media in general (Malmelin, 2010, p. 137).

Rhetorical literacy

Rhetorical literacy is the ability to understand the means of persuasion used in advertising and marketing communications in general (Malmelin, 2010, p. 136). It is an awareness of who is being targeted in a certain advertisement.

Scientific literacy

Scientific literacy is the knowledge and understanding of scientific concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity. A scientifically literate person is able to communicate clearly about the science, describe, explain, and predict natural phenomena (National Academy of Sciences, 1996).

Social literacy

Social literacy includes the ability to acquire and develop knowledge and understanding of responsible social behaviour and positive human values. A socially literate person is able to act positively and responsibly in complex social settings (Gee, 2007; Kellner, 1998; Kress, 2003).

According to Erstad (1998) we need to abandon the notion of literacy as a set of disembodied “skills” and to recognise that “literacies” are always inevitably situated within specific practices and specific social contexts. Some educators use the term *social theory of media literacy*. A social theory of media literacy needs to acknowledge that “literacies” are plural and defined by the social contexts in which they are used (Buckingham et al. 2011, p. 141).

Technological literacy

Technological literacy has a variety of meanings worldwide from the skilled use of computers, to the ability to assess, know, manage, understand, and use the technical language for a technological genre. It complements *technological competency*, which is the ability to create, operate, or repair specific technologies (Pearson & Young, 2002; Spalter & van Dam, 2008). Note that technological literacy should not be confused with *technacy*, which is the ability to understand, apply and communicate balanced and creative technological solutions that are based on understanding the contextual factors involved.

Television literacy

In accordance with Gray (1989), the Department of Education in the USA has defined CTVVS, Critical Television Viewing Skills, as “those

factors which enable persons to distinguish among a wide range of programme elements so they can make judicious use of their viewing time.” Gray concluded that programmes for critical television viewing skills could successfully be integrated into the elementary and secondary school curricula. In accordance with Gray, it would be possible for the teachers to educate critical consumers of television, as well as critical consumers of literature. Critical television viewing skills could also be called “television literacy.”

Buckingham (1993b) investigated the complex ways in which children actively make meaning and take pleasure from television. He argued that the notion of television literacy was far from straightforward. Television literacy begs many theoretical questions, and can be defined in many ways. Buckingham saw television literacy mainly as a powerful metaphor.

In his book *Teleliteracy taking television seriously* Biancculi (2000) argued for respect and serious attention to television as a medium. He explains the role of television in a modern society and sees television as an ideal forum for art, education, and information. Despite many faults television has delivered good storytelling, and positive role models. According to Biancculi teleliteracy should not be ignored, but utilized.

Another literacy?

Dake (2000) argued that an important part of literacy is the development of flexibility and fluency of thought. Buckingham (2003) used the term *new literacy* for new forms and plural notions of literacy made possible by development of digital technology. Is there is a need for another literacy encompassing reading and creating combined messages? Most messages in various media include different kinds of representations like words, graphic symbols and visuals.

Message literacy is the ability to access, analyze, evaluate, interpret, create, produce and distribute messages that are conveyed by words, visuals, forms, music, and numeric data etcetera. Message literacy helps the intended receivers to read, recognize, comprehend, experience, and understand message contents, whether conveyed to them

through print media or other media formats. Depending on the different objectives of the messages we can see different “message design genera.” These groups are graphic design, information design, instruction design, mass design, and persuasion design.

Plain language theory

Languages differ in their ability to express concepts with precision and flexibility. Chemistry, physics, and mathematics, for example, employ non-ambiguous symbol and equation languages. In verbal and technical descriptions, the language of specialists must be as unambiguous as possible. Only people with the appropriate specialized knowledge may understand languages such as these. Often normal prose is open to multiple interpretations. Pictures are often ambiguous too.

Plain language is clear with succinct writing designed to ensure that the reader understands the message as quickly and completely as possible. According to Garner (2009) plain language strives to be easy to read, understand, and use. Plain language avoids convoluted language and jargon.

Clarity of documents

According to Evans (2011) a number of organisations have published criteria for evaluating the *clarity of documents*. The Simplification Centre, at the University of Reading, has collected such criteria from ten clarity organisations across the English-speaking world. When these criteria were analysed Evans found that they varied in approach, in breadth of coverage, and in degree of details (p. 1):

Some try only to cover the use of appropriate plain words; others try to cover more or all the factors that make for an effective clear document. Some are detailed and specific; others broad and general. Which work best will depend on your purpose and the skill with which they are interpreted.

In many countries, laws mandate that public agencies use plain language to increase access to programs and services. The United Nations Convention on the Rights of Persons with Disabilities includes plain

language as one of the “modes, means and formats of communication” (United Nations General Assembly, 2006).

Plain Writing Act

In the USA the *Plain Language Action and Information Network* (PLAIN) is a group of federal employees from different agencies and specialties who support the use of clear communication in government writing. PLAIN (2010) provided guidance to federal executive agencies.

In 2010 President Barack Obama has signed the *Plain Writing Act of 2010*, which requires federal executive agencies to put all new and revised covered documents into plain language. The purpose of this Act is defined in Section 2:

The purpose of this Act is to improve the effectiveness and accountability of Federal agencies to the public by promoting clear Government communication that the public can understand and use. In Section 3 (3) the term “plain writing” is defined in the following way: “The term ‘plain writing’ means writing that is clear, concise, well-organised, and follows other best practices appropriate to the subject or field and intended audience.”

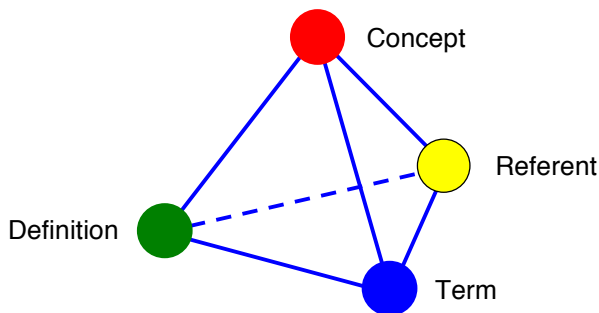
When using plain language the intended audience will understand the message the first time they read or hear it. However, language that is “plain” to one group of readers may not at all be easy to understand for other audiences. This means that in material written in plain language the intended audience can find, understand, and use the information content they need. There are many writing techniques that can help you achieve this goal. Such writing techniques include active voice, easy-to-read design features, everyday words, and short sentences.

In *plain language* the message has a high degree of *readability*. As previously noted a message has *good readability* when it is easy to understand. Many authors have stressed the importance of good readability (e.g. Kirkman, 2003, 2005; Lipton, 2007; Mackiewicz, 2004).

Terminology theory

The increasing complexity of modern society, as well as the interlinking and overlapping of subject fields make great demands on the accuracy of communication. Every subject field needs its own terminology. A *terminology* is a structured set of concepts and the terms used to represent them in a specific subject field. A terminology is also the study of the relationships between concepts and terms. The study of terminology encompasses study of concepts, conceptual models, definitions, idioms, referents, semantics, and terms.

According to terminology theory a *concept* is an idea of something formed by mentally combining all its characteristics or particulars, a mental notion of a referent. A concept is not bound to any particular language. For concepts to be represented verbally and in writing, they must be given denominative and descriptive linguistic expressions. Man is the only terrestrial species to acquire a language in the true sense of the word. However, the ability to form concepts is not unique to the human brain. Primates and several lower animals are capable of entertaining general, picture-based concepts.



A connection model, shaped like a regular tetrahedron, illustrates the connections between concept, referent, term, and definition, placed on the four corners.

A *referent* is an object linked to a specific concept, explained by a definition, and given its own specific term. The object can be abstract or concrete.

A *term*, or a *technical expression*, is the linguistic representation of a concept in a given subject field. It is often a single word, but the term

may also consist of a few words. A term can be regarded as a “label” and need not be exhaustively explanatory.

A *definition* is a linguistic description of a concept. It is based on a number of characteristics of the concepts. It should be short, precise and stylistically homogeneous. A definition must not contain words like “often” and “sometimes.” Normally it is possible to replace a term in a text with its definition.

A *subject field* is a field of human knowledge to which a terminological record is assigned.

An *idiom* is a fixed expression whose meaning is not discernible from the definitions of the individual words of which the expression is made up.

A *conceptual model* is a systematic description of the relationships between concepts in a subject field, a particular area of thought. Conceptual models are also called conceptual hierarchies or concept systems.

Semantics is the study of the meaning of verbal expressions and the implications of combinations of words.

Terminology work stands for defining concepts of a special field. The final terminology should always be user oriented for the intended audience, such as staff in an organisation. Terminology work involves continuous collection, review, description, definition, and presentation of new concepts and their terms and agreeing on recommended term equivalents in various languages. These terms should be made available as soon as possible to the people who need to have access to them in their daily work. This may be done as printed or electronic documents.

ISO/TC 37 is a technical committee within the International Organization for Standardization (ISO) that prepares standards and other documents concerning methodology and principles for terminology and language resources in the contexts of multilingual communication and cultural diversity. ISO 704:2009 is an ISO standard. This standard establishes the basic principles and methods for preparing and compiling terminologies. It describes the links between objects, concepts, and their terminological representations. Another important ISO standard

is ISO 860:2007. This standard specifies a methodological approach to the harmonization of concepts, concept systems, definitions and terms.

Lexicology deals with the structure of vocabulary. It is the part of linguistics that studies words, their function as symbols, meanings, the rules of their compositions, and relations between words. *Lexicography* also studies words, but primarily in relation with dictionaries. *Theoretical lexicography* is a scholarly discipline of analyzing and describing different relationships within a language (Bergenholtz et al., 2009). *Practical lexicography* is the actual process of compiling, writing, and editing dictionaries. A person devoted to lexicography is called a *lexicographer*. There are general dictionaries, as well as a number of specialized dictionaries. Specialized dictionaries are multi-field, single-field or sub-field dictionaries (Nielsen, 1994).

Rhetorical theory

Classical rhetorical theory was the first of all communication theories. All effective use of language comprises an element of persuasion. The classical rhetoric theory was to understand how language works and how to best use it for argumentation and persuasion. Ancient Greek scholars, like Socrates, Plato, and Aristotle noticed that spoken or written text could influence and persuade listeners and readers in different ways. The primary political skill was the ability to speak effectively (Hellspang, 1992). Aristotle identified three elements for *effective communication*: 1) The speaker, 2) The speech, and 3) The listener.

Rhetoric is not only used for text, but also for images and pictures. There are different relationships between news images, journalism and rhetoric. Images can convey strong arguments and make us make decisions. In the news media photojournalism may arouse emotions, control our perceptions, engage, and make us take sides in conflicts and crises (Mral & Olinder, 2011). A rhetoric analysis of images includes the study of allegories, doxa (assumptions, beliefs, and opinions), ethos (character and credibility), evidentia (clarity through concrete visual descriptions), logos (rational arguments and information value), metaphors, metonymies, pathos (the emotions of the audience), means for influencing (colour, layout, typography, etc.), and symbols. By drawing

on principles of information design technical communicators can design more rhetorically effective communications (Schriver, 2012).

Texts and pictures represent different languages that complement each other when they are used at the same time (Pettersson, 1989; Melin, 1999). Both can be designed, presented, perceived and interpreted in many different ways. The possibilities for using typography and layout, and for combining texts and pictures are virtually unlimited. There are always several opportunities to convey a message. Text-relevant pictures facilitate learning from reading prose (Levin et al., 1987). Most pictures are capable of several interpretations until anchored to one by a caption (Barthes, 1977).

Pictures can have a positive, a neutral, and also a negative effect on learning (e.g. Levie & Lentz, 1982; Levin et al., 1987; Massoumian, 1989; Rieber, 1994; Sims-Knight, 1992; Sung-Hee & Boling, 2010; Winn, 1993).

Today *readability of a message* involves the reader's ability to understand the style of text, the style of pictures and the style of graphical form. The choice of words, symbols, and picture elements creates the style. The readability is determined by content and formulations, and how well the language and style are adapted to the intended readers.

Semiotic studies

The development of *semiotics*, at the start of the twentieth century, was consistent with avant-garde art and design efforts to challenge prevailing ideas about the structural relationships between form and meaning (Davis, 2012, p. 131).

Eco (1971, 1976) explained that semiotics studies all cultural processes as processes of communication. Thus, there are different languages, such as spoken, written, and visual languages.

Study of signs

Semiotics is the theory of signs (Eco, 1971). A sign means nothing in itself. A sign can be a word, a sound, or a visual image. Signs are assigned meaning based on historic patterns of use that are recognized within

cultural and social groups. In any culture people have to agree on the meaning of signs. Regardless of the medium semiotics can be used for the analysis of written texts as well as images and pictures. All meanings are heavily culturally dependent. Nonverbal signs can produce many symbols with different meanings.

The concept of sign contains two aspects: 1) *Signifier*, which is the word-sound-image, and 2) *Signified*, which is the concept and message. These patterns of use are called codes. A sign comprises two types of meanings: 1) Syntagmatic meanings, and 2) Paradigmatic meanings. *Syntagmatic meaning* refers to the meaning that is assigned based on syntax, or based on the relationships among signs. *Paradigmatic meaning* is derived from other systems or codes. *Connotation* is the associated meanings of a word or a visual. *Denotation* is the basic descriptive level of that word or visual.

According to Charles Sanders Peirce (Wikipedia, 2014b) it is not possible for a sign to consist only of two parts in a two-sided paradigm. His “semiosis” is an action, or influence, which is, or involves, a cooperation of three parts in a three-sided paradigm, or *triadic model*. These three semiotic elements are: 1) Sign, 2) Object, and 3) Interpretant. A *sign* (or *representamen*) represents the denoted object. An *object* (or *semiotic object*) is that which the sign represents. An object can actually be anything at all. An *interpretant* (or *interpretant sign*) is the perceived meaning of a sign.

Semiotics has expanded in a number of directions. Regardless of the medium semiotics can be used for the analysis of written texts as well as pictures. Pictorial semiotics is connected to art history, art theory, and visual literacy. All meanings are heavily culturally dependent.

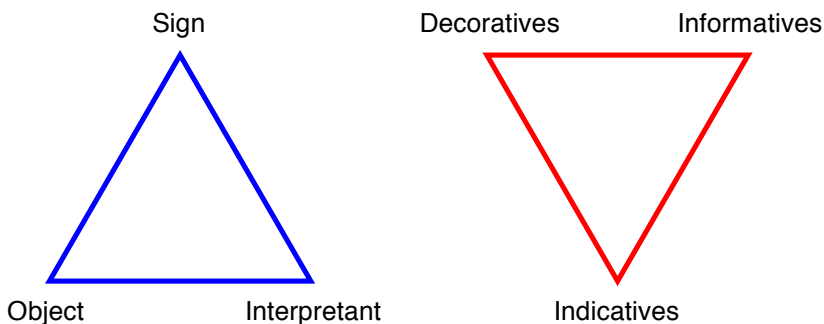
Multimodal messages combine various modes of representation and the interplay between these (Griffin, 1992; Kress & Van Leeuwen, 1996). According to Jewitt (2009, p. 14) “multimodality” describes approaches that understand communication and representation to be more than about language. Thus multimodality attend to the full range of communicational forms people use, such as body language, gaze, gesture, image, posture, sound, speech, and so on, and the relationships

between them. Multimodality can be analyzed from both *production* and *reception* perspectives (Holsanova, 1999).

The Unified Theory of ID

Based on Peirce’s triadic model Amare and Manning (2013) discussed a “Unified Theory of Information Design.” The three corners in their triangular model of this theory represent the primary categories of visual-communication goals: to evoke *feeling* (decoratives), to provoke *action* (indicatives), and to promote *understanding* (informatives). All kinds of visual artefacts and purposes of communication, including printed/written text, fit in this model. Amare and Manning have used three working definitions (p. 2):

- An *effective, ethical* visual is one that serves attainable, sustainable purposes, purposes shared jointly by both the creator and the viewers of that visual.
- An *ineffective* visual lacks the form that is adequate for its chosen purpose.
- An *unethical* visual serves purposes of its creator that are not jointly shared by viewers, or serves purposes, even if jointly shared, that are not attainable or sustainable.



Based on semiotics and Charles Sanders Peirce’s triadic model (left) Amare and Manning (2013) discussed a “Unified Theory of Information Design” (right).

According to Amare and Manning (p. 26) Peirce was correct in his claim that the meaning of any textual information, if it is understood,

has to be transformed through the mediation of diagrammatic forms into both perception (i.e., what we would see, hear, or feel if the information were true) and the action (i.e., how we would act if the information were true).

Amare and Manning identified connections between visual design elements and the grammar of language. They offer aesthetic, and ethical aspects of communication artefacts. In their book practice and theory is mainly related to technical writing. However, in my view this approach is far too narrow to constitute a “unified theory of information design.” We need to consider many more aspects than the semiotic concepts.

Pattern language theory

Recognition of patterns is as old as human beings. Prehistoric people had to learn to recognise animal and plant species and they needed to know which ones they could eat. Even today a biologist can recognize an animal or a plant species on its *habitus*, that is, the general appearance. One magpie looks like another magpie, whenever we see them. Similarly, people know their daily newspaper among many newspapers, even though the content itself varies from day to day.

Since the Neolithic period (approximately 10,000–2,000 BC) people have communicated not only through gestures and sounds, but also by means of visual language (de Jong, 2010, p. 7). In Neolithic communities people were familiar with the shape and size of their vessels, and they know the *decorations* with specific *patterns* on their pottery. Today archaeologists have named “archaeological cultures” based on these characteristic ceramics.

Until the Renaissance, artists had not many possibilities to work freely according to their own ideas (Perrig, 1995, p 422). They usually worked after very detailed orders. It was common for masters to use “pattern books” where clients could choose among different models for different types of subjects, both religious and secular.

After his theoretical studies of architecture, central perspective, and sculpture Leon Battista Alberti (1404–1472) concluded that *beauty and harmony* of a building is more important than the actual purpose

with the building and the resulting demands of suitable building materials. Alberti was very influential and his line of thought that “function follows form” became a leading doctrine in architecture and aesthetics for hundreds of years. As previously noted today’s design motto is very much: “function can take any form.”

In many fields experienced practitioners are often able to recognise problems they have met before. They remember possible solutions and they may use them again. The French sculptor *Auguste Rodin* (1840–1917) was a pioneer in modern sculpture. He worked in clay in an object-oriented manner and used the same form elements in several sculptures. He modelled the human body with realism and departed from traditional decorative tradition. The original sculpture *The Thinker* is 71.5 cm high (1888). Later a large number of bronze versions were made in various sizes. During the peak of his career Rodin had up to 50 assistants.

It seems that the idea of patterns is fundamental to human thought. In architecture Alexander et al. (1977) collected a series of 253 patterns of successful environments. The book created a new language, what the authors called a *pattern language* derived from timeless entities called patterns. This is a structured method of describing good design practices within a field of expertise. Patterns describe a problem and then offer a solution. The patterns were presented systematically in a *pattern library*. Pattern libraries have been a common way to share design solutions in architecture. Today pattern libraries are often used in computer science, interaction design, and in software engineering to share best practice.

Waller and Delin (2010) discussed the use of a “pattern language approach” in layout and typography of functional texts. Here *pattern* refers to configurations consistently found within recurring design solutions to common problems. Today many organisations use guidelines, or even distinct rules, for the use of layout and typography in their documents. For example many insurance companies set up standard styles for customer communications, and textbooks in a series all “look” the same. Different style manuals have different recommenda-

tions for when italic and bold type versions should and shouldn't be used (Samara, 2007).

In particular Waller and Delin (2010) wanted to demonstrate the frequency of patterns within financial services documents, and test how users with different levels of experience could use such documents. They wanted to place patterns in the context of genres and established reading strategies. According to Waller and Delin (2010) a pattern language approach is attractive for information designers. This approach corresponds closely to how design is traditionally taught and practised. A documented pattern should explain why that solution is good in the context of the pattern.

Visual language theory

A general principle of human communication is that the likelihood of successful communication increases when a concrete reference is present. In the absence of the actual thing, the next best reference is a visual representation of that thing. An image or a picture is sometimes a more pertinent reference for meaning than the spoken or written word.

Avgerinou and Pettersson (2011) concluded that visual language has the following constituent parts: 1) Visual language exists; 2) Visual language is holistic; 3) Visual language must be learned; 4) Visual language may improve learning; 5) Visual language is not universal; 6) Visual language often needs verbal support. As in the case of verbal language, visual grammar, syntax and vocabulary have been ascribed to visual language, while their particular functions have by and large been identified.

Visual languages have “analogue coding” employing combinations of basic graphic elements (dots, lines, areas, and volumes). A given set of basic elements can be combined to form completely different images. Meaning is apparent on a basic level, but the visual language must be learned for true comprehension.

Visual communication

In contrast to spoken and written languages, pictures have no general and distinguishing elements that are not bearers of information. Visual

languages attempt equivalence with reality. Visuals are iconic and they often resemble the thing they represent. Images speak directly to us in the same way experience speaks to us, that is, emotionally and holistically (Barry, 1998). Language and cultural differences could impact the effectiveness of visuals (Kovalik, 2005). Therefore it is always important to select pictures with great care.

Since the beginning of mankind we have been using body languages and different kinds of signs for communication. Visuals are cultural products shared by individuals (Griffin et al., 1996; Moriarty and Rohe, 1992), as such, they are understood within individual people's frames of reference (Kovalik, 2005; Singer, 2010). Visual messages are superior to verbal messages when content is emotional, holistic, immediate, spatial and visual (Boeren, 1994; Brouwer, 1995; Hugo, 1996; Zimmermann & Perkin, 1982). Meaning is immediately apparent on a basic level, but the visual language must be learned for true comprehension (Barry, 1998).

Visual messages are a powerful form of communication (Lester, 1995, p. 73) and an increasing number of decisions are made on the basis of pictorial representations (Nielsen, 2004). Visual messages stimulate both our emotional and our intellectual responses and therefore make us feel as well as think.

All types of visuals are not equally effective. Line drawings are most effective in formats where the learner's study time is limited. More realistic versions of artwork, however, may be more effective in formats where unlimited study time is allowed. The realism continuum is not an effective predictor of learning efficiency for all types of educational objectives. An increase in the amount of realistic detail will not produce a corresponding increase in learning. No pictorial image gains the status of a "statement," unless an explicit reference is made to what it is supposed to represent (Gombrich, 1969).

There is often a considerable disparity between the sender's "intended message" and the receiver's "perceived message." Each receiver will place available information in an expanded, a wider, "personal" context. Indeed, it is sometimes doubtful whether the receiver has understood anything at all of what the sender wants to convey. Listen-

ers and readers create their own associations and chains of associations. As far as ambiguous pictures are concerned there is often a major difference between their *denotation*, i.e., their literal meaning, and various *connotations*, i.e., their associative meanings and private associations (Pettersson, 1995). Most people believe that pictures tell the truth (Lefferts, 1982). However few realize that what they think they see in pictures depends on what they expect to see in them (Berthoz, 2010), and are expected to learn from them (Singer, 2010). Familiarity with the depicted objects themselves is basic and crucial to understanding (Zimmermann & Perkin, 1982). The more familiar a message is to its intended audience, the more readily it is perceived. Usually receivers are capable of interpreting far more content in a given picture than the designer had in mind.

We cannot understand pragmatics, semantics, and syntax of visual languages by using only the linguistic concepts developed to analyze spoken languages. In verbal languages, *syntax* is the study of the rules for combining words into grammatical phrases, clauses, sentences and paragraphs. In visual languages, *syntax* depends upon the spatial arrangements of the visual elements on a page (Horn, 1998, p. 75). Our ideas about good arrangements depend on how our perceptual system works. Many ideas are best expressed by visual language, and others can only be expressed by visual language (Horn, 1999, p. 28).

Using a large number of visual examples Malamed (2009) offers designers six principles for creating graphics and *visual language* that people may understand. These principles are called: 1) Organize for perception. 2) Direct the eyes. 3) Reduce realism. 4) Make the abstract concrete. 5) Clarify complexity. 6) Charge it up. Nowadays the study of visual communication is a multi-disciplinary, multi-dimensional and worldwide consideration.

Combined verbal and visual language

Texts and pictures represent completely different languages that complement each other when they are used at the same time. Both text and images can be designed, presented, perceived and interpreted in many different ways. The possibilities for using typography and layout, and

for combining texts and pictures are virtually unlimited. The interplay between text, picture, and graphic form needs to be studied thoroughly before optimal combinations can be found. There are always several opportunities to convey any message.

Readers often react in a positive way to graphically complex texts. Texts with good typography will be noticed (Melin, 1999). Dissatisfaction with the execution of a message may cause dissatisfaction with the actual content of the message. It is more likely that graphically complex texts will be read than “plain” texts. It also takes less time to read a graphically complex text than a “plain” text.

Pictures that will be used for information purposes should always be supplied with captions. This is the only way to assure that information conveyed by these pictures is clear and unambiguous. Even simple pictures need plain captions for the contents and presentation to be conveyable in verbal form. Captions should be written with great care. They heavily influence our interpretation of image content. To a large degree readers see what they are told to see in an image. To get maximum impact from a visual, the writer or the presenter should introduce the visuals before presenting it. We create a “pre-understanding” of how a picture may be interpreted, based on the context in which the picture is shown (Pettersson, 1989).

Despite all efforts during the past decades *visual literacy* has not been able to attract enough interest from society and enough interest from those who are responsible for the school curricula around the world. An important reason for this may be a general lack of focus. In my view we need to consider combined verbal and visual representations, not only text and not only visuals when we study communication. This is where message design, and its different sub-areas, may play an important role for visual literacists.

In his discussion on “*Presentation media for product interaction*” Westendorp (2002, p. 48) noted that *instructive elements* in or near a drawing have evolved rapidly into a special “instructive language.” Instructive elements: “are purely symbolic: there are no physical hands, reference letters, numbers and lines, arrows, crosses, dotted lines, exclamation marks, circles, zoom-lines or greyed-out or coloured areas on

the products.” Apart from arrows, lines and pointing hands most instructive elements were introduced after World War II.

Some instructive elements are “statements” comparable with individual words (Pettersson, 2000; Westendorp & Van der Vaarde, 2001) or even sentences. A good symbol is designed so it can be used in many different situations and in many contexts (Pettersson, 2000). A good symbol is simple, clear, has optimal size, good contrast in form, dimension, and colour. There are, however, cultural as well as individual differences in interpreting the meanings of symbols.

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, and represent an organization, a service, or a product. Graphical symbols may supply information and supply instructions.

Visual literacy theory

The term “Visual Literacy,” or more often “visual literacy,” may be modern. However, it is not at all a new idea. Discussions about the use of images have a long history. Visual literacy, or *visuacy*, is a broad concept with bits and pieces from several areas of knowledge. Leahy (1991) pointed out that Aristotle had formed the conceptual idea that certain elements of visual grammar are necessary to visual composition and appeal. Aristotle provided a seminal notion that art and visual literacy theorists Arnheim (1969, 1986) and Dondis (1973) further refined. And Moore and Dwyer (1994) noted that visuals might be the main source for information and communication in many cases today.

There are many aspects of visual literacy and there are many aspects of the use of images for various purposes. Velders (1999) concluded that (p. 10): “The history of visual communication goes back to the cave paintings 30,000 years ago, the description of it only 2,500. ... visual literacy is 2,500 years old (as a skill) and 30 years young (as a term).” Braden (1987) identified three “domains” of visual literacy:

- Visualization, described as “aspects of vision in the human process of thinking and communication” (p. 7). In this domain Braden included elements such as visual syntax, visual design, visual expression, and visual thinking.
- The “theory–research–practice trilogy as it applies to visual literacy” (p. 6). This includes elements such as instruction, design, communication, and persuasion.
- Technology, including the effects of technological developments upon the other two domains of visual literacy. Braden included in this category electronics and television, computers, and reprographics.

Griffin and Whiteside (1984) argued that visual literacy theory should stimulate practical applications, and they suggested that visual literacy should be approached from the *theoretical perspective*, which incorporates the philosophical, psychological, and physiological aspects of learning. It should be approached from the *visual language perspective*, which incorporates a receiver-oriented approach committed to helping people become visually literate by effectively relating to visual stimuli. Visual literacy should also be approached from the *presentational perspective*, which incorporates a presenter-oriented approach, and the improvement of the communications process through design of visual stimuli.

Visual literacy is a broad and interdisciplinary concept including biological perspectives, communication perspectives, educational perspectives, religious perspectives, social perspectives, technological perspectives, visual language perspectives, and bits and pieces from several other “established fields” of research.

The International Visual Literacy Association, IVLA, was established as a non-profit association incorporated in the State of New York in 1968 to provide a multi-disciplinary forum for the exploration, presentation, and discussion of all aspects of visual communication and their various applications through visual images, visual literacy, and literacy in general. IVLA serves as the organizational base and communications bond for professionals from various disciplines that are interested in visual literacy.

Definitions of visual literacy

Several researchers have developed definitions, opinions, and viewpoints about visual literacy (e.g. Avgerinou 2000; Debes, 1969; Dondis, 1973; Pettersson, 2002; Yeh & Lohr, 2010). There has been, and there still are major disagreements among researchers and practitioners concerning a precise definition of visual literacy. In my view so far Heinich et al. (1982, p. 62) have provided the best definition of visual literacy. They wrote:

Visual literacy is the learned ability to interpret visual messages accurately and to create such messages. Thus interpretation and creation in visual literacy can be said to parallel reading and writing in print literacy.

However, a large Delphi study showed that the visual literacy scholarly community has not been able to agree on a definition of visual literacy (Brill & Kim, 2007; Brill, Kim, & Branch, 2007). Visual literacy definitions have varied from very narrow to very broad explanations of greater or lesser complexity. In accordance with Avgerinou and Ericson (1999, p. 22) there seem to be as many definitions as there are visual literalists. Avgerinou (2003) found that *what the various definitions share in common is greater than what separates them*. Her close examination of visual literacy definitions showed that visual literacy is referred to *ability, competency, or skill*.

Many current definitions of the term visual literacy has an emphasis on *creating visual materials*, not just interpreting visual messages (Brumberger 2011; Hattwig et al. 2013; Felten 2008). According to Mayall and Robinson (2009, p. 49) in-service teachers' failure to incorporate visual literacy tools in instruction stem from a lack of knowledge of the "theoretical principles and guidelines."

Visual literacy is an interdisciplinary, multidisciplinary and multidimensional area of knowledge, and it encompasses influences and facts from many established areas of knowledge and research. Having considered a vast literature on visual literacy, Avgerinou and Pettersson (2011) proposed that a *theory of visual literacy* should be grounded on the following conceptual components: 1) Visual percep-

tion, 2) Visual language, 3) Visual learning, 4) Visual thinking, and 5) Visual communication.

It is clear that it may be very difficult to describe verbally a concept that is primarily nonverbal. Sosa (2009, p. 55) noted: “the term ‘visual’ is evolving and intuitive and has different meanings for different people so, too, ‘visual literacy’ also may have a variety of meanings.” This is really true. Braden (1996), Elkins (2003), Machin (2007) and some other researchers have practically rejected the concept of “visual literacy” and they search for something else, like communication design, information design, or message design.

Visual literacy abilities and competencies

According to Avgerinou (2003) *visual literacy ability* has been specified as: 1) To read/decode/interpret visual statements, 2) To write/encode/ create visual statements, and 3) To think visually. It's not enough to simply receive a message in a passive manner. A truly visually literate person must be able to construct meaning out of the images that are shown (Felten, 2008).

A truly visually literate person must be able to construct meaning out of the images that are shown (Felten, 2008). It's not enough to simply receive a message in a passive manner.

According to Coleman et al. (2010) an “effective use of graphics” is multifaceted. It includes being able to organize information, to create graphics, to read graphics, to locate specific information within a graphic, and to communicate with others through the use of graphics. The effective use of graphics must be taught (Gerber et al., 1995; Kress and van Leeuwen, 2006).

When Schiffman (1996, p. 76) studied information design guidelines for designing and evaluating visual components of educational materials for ethnic populations within the USA she concluded that it is necessary to adopt visual messages to various ethnical groups: “Visually translating health educational materials will be critical to the success of communication efforts, particularly as our population continues to change ethnically and less developed countries continue to develop.”

Matusitz (2005) found that American students might be characterized as (p. 101): “passive consumers in the classroom.” Students are not employing critical analysis of visual communication. And Felten (2008) noted that it's not enough to simply receive a message in a passive manner. A truly visually literate person must be able to construct meaning out of the images that are shown. According to Brumberger (2011, p. 21) the best definitions of visual literacy contain “both an interpretative and a productive component.”

When Paquin (1999) discussed “competencies of visual literacy” he combined visual literacy skill perspectives presented by Fransecky and Debes (1972), Hansen (1989), and Seels (1994), with the “visual literacy outcome perspective,” proposed by Ragan (1988). Paquin created what he called an “expanded taxonomy of visual literacy outcomes” (p. 247). The “expansions” are the addition of outcomes that require combining of visuals and verbal information for successful visual communication. In the table on the next page these expansions are set in blue text. This expansion makes the model interesting for information design.

Paquin's expanded taxonomy of visual literacy outcomes.

<i>Level</i>	<i>Manipulation</i>	<i>Construction</i>	<i>Abstractions</i>
Primary	Holding, touching and changing objects in the environment.	Creating simple works, paintings, cut outs. Taking pictures.	Identification of concepts—sizes, shapes, colours, names with objects.
Skilled	Using tools for problem solving; sewing, taking apart and reassembling things. Sequencing and describing photographs.	Drawing with perspective. Controlling variables when taking/processing pictures. Origami or other complex constructions. Interpreting and following mixed instructions.	Creating visual plans/patterns in two dimensions. Specifying photographic treatment for objects, actions and sequences. Creating visuals from verbals and vice-versa.
Advanced	Mental manipulations of complex representations; maps, multivariate statistical models.	Ability to draw imagined objects in 3-D, producing original conceptualizations. Processing one's own original photographic style. Develop meaningful charts and graphs from given data sets. Creating flyers, advertisements or other mixed communication.	Multiple holistic appositional forms of abstract thought; lateral thinking, visual intuition, unique visual invention. Describe conceptual visual ideas verbally.

Visual literacy skills

The visual literacy skills are not isolated from other sensory skills. It is generally believed that there is exchangeability of information received and transmitted by all sensory channels. Given this, visual literacy is thought to improve the development of verbal (written and oral) literacy (Avgerinou, 2003). The visual literacy skills are: 1) Learnable, 2) Teachable, and 3) Capable of development and improvement. Although research has not always substantiated these allegations, most visual literacy definitions are centred on them.

Felten (2008, p. 60) concluded: “living in an image rich world, however, does not mean students (or faculty and administrators) naturally possess sophisticated visual literacy skills.” According to McKenzie (2008, p. 1) the ability to create and interpret information from a multiplicity of visual sources is becoming a “survival skill” in today’s schools. Hattwig et al. (2013) argued for higher education’s support of visual literacy since it represents essential competencies for 21st century learners.

Hugo and Skibbe (1991) concluded that medical and health educators in South Africa are facing many problems related to lack of visual literacy skills. Communication and education often fail because some groups are unable to interpret visual messages correctly. In South Africa pictures can often be a hindrance rather than an advantage in teaching. The misconception that any visual material has educational value still exists. Hugo and Skibbe found that visual literacy might be a key factor in effective medical and health education. Also Brouwer (1995) concluded that pictures are not always effective as a means of communication with illiterates in rural Africa. Visual language and visual conventions need to be taught just as much as a verbal language.

In South Africa deLange (1996) proposed that adults in developing countries, that are not exposed to a visual culture as found in North America and Western Europe, might never develop a basic ability to read pictures. Their frame of reference and their level of understanding could possibly extend only to the limited number of visuals that they have actually been in contact with. Thus, it may not be enough to merely modify visuals in print media for these cultures. In many situations new pictures may be needed.

Cognitive disciplines

There are numerous competing and complex theories of *learning*, *memory*, and *knowledge*. There is an on-going debate, and there are many different views. Acquisition of knowledge involves complex cognitive processes, such as attention, perception and learning. These processes are influenced by our earlier experiences and our memories. Groups of brain cells are activated and associate to each other. Information is converted into experience and insight. Then experience and insight are converted into knowledge, and ultimately into wisdom (Shedroff, 1999, p. 269).

Some researchers are trying to develop a single comprehensive *learning theory* encompassing all the different kinds of learning. As far as I know no such attempt has yet been successful. More than fifty different learning theories have been described (Kearsley, 1999). However, so far there is no theory of learning that is widely accepted (Uljens, 1992).

A number of theories describe the transfer of data and information into memory. Our memories make it possible to store experiences, recognize things, and learn. With the help of our memories we can think and tackle the problems that face us. Memories give us a place in the time dimension. Memories become a part of our personalities. However, whether memory is a basic source of knowledge or not is a controversial issue. According to Bernecker (2015) some philosophers maintain that memory only retains or preserves knowledge but doesn't produce new knowledge. Others, however, insist that there are cases where a person first comes to know by remembering.

Complicated language, in both texts, pictures and graphical form will impair the understanding of any intended message. The information designer needs to *facilitate* attention, perception, learning, and memory of the messages provided in information sets. The intended audience must be able to notice the message, and then mentally process the data. It is important to have clear objectives. However, in information design actual *learning* is rarely required.

Approaches to knowledge

Memory and knowledge are not the same. Knowledge is about much more than memory, especially about *understanding*. From the literature one can easily get the impression that academic and scientific interest in the concept *knowledge* has increased in recent years. Many authors have different opinions of what knowledge is and what it is not, and there are a number of alternative definitions and taxonomies.

To the Greek philosopher Plato (428–348 BC), knowledge was “a priori” in place in the mind already at birth. Learning was a process of recalling what the soul had already absorbed in an earlier life. To Plato, the pupil was a spectator of reality, and teaching was just helping of the remembering process. In order to be considered knowledge Plato argued that a statement must be: 1) Justified, 2) True, and 3) Believed. Some claim that these conditions are not sufficient.

The Greek philosopher and scientist Aristotle (384–322 BC) was a student of Plato. He insisted that perceptions and not ideas are the base for reality (Johannesson, 1999, p. 15). Also Aristotle described three approaches to knowledge: 1) Episteme, 2) Techné, and 3) Phronesis.

Episteme means scientific knowledge, “to know.” Aristotle's scientific knowledge is context-independent, invariable, and universal. It includes only what is absolutely necessary. These necessary conditions are eternal and immutable. The other two types of knowledge involve conditions that change over time. The Greeks viewed episteme as a partner to the second approach, techné.

Techné means “skills and crafts.” We can both learn and forget skills and crafts. To have such knowledge is to be able to do something meaningful on the basis of the circumstances with the resources actually at our disposal. We may have enough knowledge about something we need to do. However, we might not be able to actually do it. Aristotle viewed techné as an imperfect human representation of nature. Today the original concept techné appears in terms such as “technique” and “technology.”

Phronesis means “practical wisdom.” Practical wisdom means that we know which action is morally correct in a given situation. We can neither learn nor forget practical knowledge. Aristotle's concept of

knowledge includes elements of good judgment as well as individual reflection. This is influenced by every specific and unique situation.

The Greek word *epistemology* aims to discover the meaning of knowledge. It is the branch of philosophy concerned with the nature and scope of knowledge, or a *theory of knowledge*. For our purpose in this paper *knowledge* refers to having awareness, facts, information, skills, and understanding of someone or something. Knowledge allows us to see new patterns, draw new conclusions and then create new knowledge. So far there is no consensus among those participating in this debate and there are numerous competing *theories of knowledge*. To some extent, the debate has focused on how the *theoretical knowledge traditions* stand in clear opposition to the *practical knowledge traditions*.

Theoretical knowledge traditions

A theoretical understanding of a subject is *explicit*, while practical expertise and skills are *implicit*. There are several theoretical knowledge traditions.

Explicit knowledge

Explicit knowledge, or *codified knowledge*, can be readily accessed, articulated, codified, and verbalized (Nonaka and Takeuchi, 1995). Many kinds of explicit knowledge can be stored in media and easily be transmitted to others. Good examples of explicit knowledge are data and information contained in encyclopaedias and textbooks. Explicit knowledge can be of several forms, such as *declarative knowledge*, *procedural knowledge*, and *contextual knowledge*.

Declarative knowledge (knowing that...) is defined as the factual information stored in memory and known to be static in nature (Tennyson, 1994). Declarative knowledge is also called *descriptive knowledge* and *propositional knowledge*. Declarative knowledge is expressed in declarative sentences or indicative propositions and specifies what action to take when one is presented with a set of stimuli.

Procedural knowledge (knowing how to...) is the practical skills of *how* to perform a task (Tennyson, 1994). This “know-how”-type of

knowledge is formed by doing and cannot be easily articulated by the individual. It permits a professional to determine which treatment or action is best, even in the presence of significant noise. Procedural knowledge is also called imperative knowledge and implicit knowledge.

Contextual knowledge (knowing the conditions: why, when, and where) means understanding of knowledge in its context (Tennyson, 1994). One example is how knowledge is situated in organisational contexts (Goldkuhl and Braf, 2001). This type of knowledge will usually involve an understanding of underlying theory and/or a range of experience of an area.

Nonaka and Takeuchi (1995) proposed a *knowledge spiral* to explain how individuals and groups convert knowledge from a tacit to an explicit form and vice-versa, and share both tacit and explicit knowledge. Nonaka, Toyama and Nagata (2000) further developed this model. Here the helix reproduces an upward evolutionary path, with an unlimited continuity perspective, in which the reaction loops do not tend to close in the form of the classic feed-back but act as virtuous circles (Miron, 2008).

Traditional academic view

A traditional academic and theoretical view is that we can only have knowledge of things that we can demonstrate with empirical data, or about things that we can prove with formal methods and then articulate by verbal means, or in some other notational form. Here, writing and reading is seen as universal tools for the transfer of knowledge from one person to another.

These scientific traditions have developed prescriptive scientific methods on collection of data through experimentations and observations, and then processing of data in different systematic manners. However, Feyerabend (1975, 1978) challenged the traditional scientific traditions and argued that there are no methodological rules that scientists always use. Constant use of any single prescriptive scientific method would restrict scientific progress. In fact, such mandatory methodological rules would have prevented scientific progress in the past.

With a limited and restricted approach everything other than what is possible to describe with words, numbers and other characters will fall outside of the traditional academic area of knowledge.

Pragmatic process-perspective

Johannesson (1990a) discussed four different aspects of knowledge. It is the pragmatic process-perspective: 1) Propositional knowledge, 2) Competence knowledge, 3) Familiarity-knowledge, and 4) The judicious aspect.

Propositional knowledge is expressed by some kind of linguistic means in declarative sentences or indicative propositions. It can be formulated in terms of principles, rules and theories. The character of factual knowledge makes it possible to use exact wordings. It is, however, not the only type of knowledge that is scientifically relevant. Propositional knowledge is also called *declarative knowledge* and *descriptive knowledge*.

Competence knowledge means that a person has rehearsed and master practical skills. This is the “skill aspect” of knowledge. *Procedural knowledge* is the knowledge of *how* to perform a task. These practical skills are expressed in a safe touch when a task is to be performed.

Familiarity-knowledge, or the *familiarity aspect of knowledge*, cannot be formulated as rules and it cannot be expressed in any exact way.

The judicious aspect of our practically acquired conceptual hold on reality can be seen as a result of a fusion, or a synthesis, of the other three aspects of knowledge. The judicious aspect includes the establishing, application and mediation of knowledge.

Situated knowledge

Based on feminist studies and post-structuralism Haraway (1998) developed the concept of *situated knowledge* in response to the *standpoint theory*. In post-structuralism the author's intended meaning is secondary to the meaning that the reader perceives. Knowledge that is specific to a particular situation is called *situated knowledge*. Haraway

noted (1998, p. 580): “we do need an earth-wide network of connections, including the ability partially to translate knowledge among very different—and power-differentiated—communities.” Coming to terms with the agency of the “objects” studied is the only way to avoid gross error and false knowledge. Situated knowledge is the only kind of knowledge there is, and it will always be partial (Griffin, 2009). It is a form of objectivity related to science studies, which is supposed to offer a better account of the world. Knowledge is often embedded in culture, language, and traditions. People from lower status communities “experience” more and have a more complete and diverse knowledge of the world.

Worlds of knowledge

According to Lövgren (2007) the foundation for knowledge is communication. Knowledge is a man-made concept. It relies on mutual understanding of at least two human beings. Knowledge comes from data interpreted by humans for answering human questions for the use of humans. Mutual understanding among people (in principle the more the better) is essential for establishing more robust knowledge, which the methods of the scientific world exemplify!

As an alternative to the concepts “theoretical knowledge” and “practical knowledge” Lövgren (2007) defined two types of “knowledge worlds.” These knowledge worlds are called: 1) Abstract worlds of knowledge, and 2) Concrete worlds of knowledge.

An *abstract world of knowledge*, e.g. mathematics and theoretical philosophy, has an absolute existence. It is self-contextual, and it is time independent. It is eternal.

A *concrete world of knowledge*, e.g. aesthetics and biology, has a relative existence. It is always contextual in space and in time, and it is time dependent. Here knowledge must correspond to phenomena in the concrete world. We may see this knowledge as ongoing current interpretations.

Practical knowledge traditions

As previously noted practical expertise and skills are *implicit* while theoretical understanding of a subject is *explicit*. There are several practical knowledge traditions.

Tacit knowledge

The scholar Michael Polanyi (1891–1976) made important theoretical contributions to chemistry, economics, and philosophy. Polanyi (1946) argued that a positivist account of science supplies a false account of knowing. He found that it ignores the role personal commitments play in the practice of science. Polanyi (1958) argued that all knowledge claims rely on personal judgements. All knowing relies upon commitments. Our tacit awareness connects us with reality. He introduced the term “tacit knowing” or “tacit knowledge.”

In his book *The Tacit Dimension* (1966) Polanyi distinguished between the instrumental, ontological, phenomenological, and semantic aspects of “tacit knowing/tacit knowledge.” Already at the beginning of the book Polanyi noted the following (p. 4): “we can know more than we can tell.” It is obvious that we take many perceptions, sensations, social rules and values for granted when it comes to human behaviour. The key to acquiring tacit knowledge is *experience*. Once we have learned how to use various tools we don't have to think about it any more. Knowing the explicit knowledge, however, is no real help in using a hammer.

Michael Polanyi argued that tacit knowledge plays an important role in both practical as well as theoretical knowledge, although it is not possible to give it an explicit formulation. Polanyi wanted to show that even nationalist and positivist theory of knowledge must rely on human and social processes that are not fully understood or even examined critically in a scientific way.

Polanyi's “concept tacit knowledge” is based on knowledge of philosophy and social philosophy. But the “term tacit knowledge” has sometimes been associated with Ludwig Wittgenstein (1889-1951) and his work with *philosophy of language*, which is concerned with four

central problems: 1) The nature of meaning, 2) Language use, 3) Language cognition, and 4) The relationship between language and reality.

Polanyi and Wittgenstein agreed that there is always knowledge that is not formulated in a linguistic way with the help of words. Wittgenstein argued that there is knowledge which by its nature is somewhere beyond the limits of language. However, for Polanyi it was not certain that it is not possible to describe all kinds of knowledge with verbal language. The fact that we do not express some knowledge verbally does not actually mean that it is not possible to do so.

As previously noted Johannessen (1990a) observed that *propositional knowledge* is not the only type of knowledge that is scientifically relevant. Some scholars have accepted that it might be legitimate to talk about knowledge also in cases where it is not possible to articulate it in full measure by proper linguistic means. Using Polanyi's terminology Johannessen called the kind of knowledge that cannot be fully articulated by verbal means for *tacit knowledge*.

The concept "tacit knowledge" is nowadays used in many areas and in many situations such as: artificial intelligence, business, care, education, healthcare, industrial production, innovation, management, and organizational learning. Göranson and Josefson (1988) edited a book about artificial intelligence, knowledge, and skills. Engel (2008) investigated tacit knowledge and implications for medical education.

Implicit knowledge

As previously noted practical expertise or skills are typically *implicit*. *Implicit learning* is the learning of complex information in an incidental manner, without awareness of what has been learned. Implicit knowledge is knowledge that is not explicit like tacit knowledge. It has not yet been codified, while tacit knowledge may well be impossible to codify. Implicit knowledge is somewhere between explicit knowledge and tacit knowledge.

Competence knowledge means that a person has rehearsed and master practical skills. This is the "skill aspect" of knowledge. Competence is the strategy a professional would apply in practice if given the opportunity.

Different interpretations

There are different interpretations of Polanyi's concept of tacit knowledge. In 1991 Grimen discussed three interpretations (Yu, 2006). One interpretation was called "the Gestalt thesis of tacit knowledge." When one person is engaged in a certain activity, such as riding a bicycle, that person has to rely on an unarticulated background. In the process of performance the agent himself cannot articulate an unarticulated background.

Another interpretation is called "the thesis of epistemic regionalism." At any given moment, one person can only reflect on small parts of the knowledge system and verbally articulate them. It is not possible to verbally articulate all that we know.

A third interpretation is called "the strong thesis of tacit knowledge." Some specific kinds of knowledge are, in principle, not possible to articulate verbally. In such cases there exists a logical gap between our capacity of cognition on the one hand, and our capacity of verbal articulation on the other.

According to Grimen (Yu, 2006) the knowledge that we in principle cannot articulate verbally is *tacit knowledge*. It can be accumulated, criticized, learned, and transferred. However, the modes of accumulating, articulating, criticizing, learning, and transferring tacit knowledge are different from the modes of verbally articulated knowledge.

Rolf (1991) made a careful analysis of Polanyi's ideas about "tacit knowledge." In addition to the categories "the understood" and "the misunderstood" there is also the category "the implied." Even the word "knowledge" itself has different connotations and can be perceived in different ways by different people. The author noted that the German expression "implizites Wissen" better matches the original spirit of Polanyi's text. Rolf discussed three categories: 1) Emergence of knowledge (how we learn something), 2) Content of knowledge (what we know now), and 3) Function of knowledge (what we use knowledge for). Rolf noted that Polanyi's theory of tacit knowledge involves the function of knowledge. This function is expressed in a person's ability to use her or his own knowledge in any specific action, or the ability to acquire new

knowledge when necessary. So we do not always articulate our knowledge in words.

Transitive verbs are action verbs that require a direct object. The verb's action is transferred directly to the object, which can be a noun, pronoun, phrase, or clause. Intransitive verbs don't require a direct object. According to Johannessen (1990b) *intransitive understanding* is autonomous. It does not relate to anything else and it is a global phenomenon. *Transitive understanding* on the other hand can be translated into other media of expression. In intransitive understanding a work of art is grasped individually as an entirety, and a particular kind of experience that involves a feeling of familiarity.

Today, perhaps we can say that tacit knowledge refers to the practical experience, the familiarity and expertise and the practical know-how that is gathered by groups of professionals, i.e. knowledge of how to do anything. We can recognize things and we can do things without being able to verbalize and explain how we recognize something or exactly how or why we are actually doing something in a certain way.

Long life experience

We acquire our tacit knowledge gradually through practice and long life experience. We cannot formulate and transmit tacit knowledge in a complete and traditional way by using words and images in fiction books, in textbooks or in other media. Two typical examples of tacit knowledge are: 1) "To (be able to) ride a bicycle," and 2) "To (be able to) recognize a face" (Molander, 1996, p. 41).

No one can give a full description and provide complete instructions on how to ride a bicycle so that another person can read it, and immediately be able to ride the bicycle without any problems in the traffic. It is obvious that many people learn to ride a bicycle without the ability to explain exactly what is happening and why it occurs. The same applies when we recognize a face. At the beginning of his book *The Tacit Dimension* Polanyi noted (p. 4): "We know a person's face, and can recognize it among a thousand, indeed among a million. Yet we usually cannot tell how we recognize a face we know. So most of this knowledge cannot be put into words." A few other examples of activities

based on tacit knowledge are: boiling an egg, driving a car, hitting a nail with a hammer, making a cup of coffee, and playing the piano.

It is easy for an experienced biologist to recognize an animal or a plant species based on general appearances. A great tit always looks like a great tit, and never like a goshawk or a magpie. Similarly, newspaper readers know the look of their daily newspapers, despite the fact that the actual content, of course, varies from day to day. We can easily see if there is a significant change in the design. This reasoning would largely apply to images that we use in information materials and in teaching aids. With the help of pictures and movies, we can learn how animals in foreign countries look like and how they live, even if we never get the opportunity to see them in real life. But so far a film or a video cannot completely replace a real experience.

Molander (1993, p. 54) argued that tacit knowledge covers areas such as attention, experience, familiarity, judgment, personal commitment, security, skills, talent, and understanding. Much of this is within the individual's own habitat. The craftsman's or the expert's knowledge is a living part of the person (Molander, 1993, p. 229). The emphasis is however on their own action, attention, and understanding. We must therefore trust our own knowledge and our own skills, but we also need to be aware and know our own limits. It is necessary to be able to shift perspective—this is a matter of attention, ethics, and insight.

Organisational knowledge

When individuals pool all their individual knowledge within an organization, that *organizational knowledge* can give an advantage over others working in the same field. Organizational knowledge exists in the form of routines resulting from an accumulation of past experience that guide future behaviour.

Haldin-Herrgård (2000) recognised difficulties in diffusion of tacit knowledge in organizations. Lam (2000) studied organizational learning and tacit knowledge in societal institutions. Grensjö (2003) discussed education in the workplace. In addition to tacit knowledge Grensjö also discussed silencing and *silenced knowledge* related to de-

mocracy and power. Irick (2007) discussed tacit knowledge in business from a management perspective.

Nonaka and Takeuchi (1995, p. 59) pointed out that tacit knowledge is personal, context-specific, and difficult to formalize and to communicate to others. It is highly rooted in action and experience. Tacit knowledge can be restricted to just one individual, or be shared within a group of people. Much of what constitutes excellence in organizations is tacit knowledge that can only be passed on through personal interaction between employees in social networks in the organizations. Nonaka and Konno (1998) studied how to advance collective and individual knowledge in physical and virtual environments.

Metaknowledge, or *meta-knowledge*, is knowledge about knowledge. This is important in knowledge engineering and knowledge management. *Knowledge engineering* is the scientific, social, and technical aspects involved in building, maintaining and using knowledge-based systems. *Knowledge management* is the process of capturing, developing, effectively using, and sharing organizational knowledge (Nonaka, 1991).

Attention theories

One of the message designer's and information designer's first problems is to catch the attention of the members of the audience. Then it is up to the designer to hold their attention. Any information set must constantly redraw the attention in order to hold the interest of the viewers alive.

Attention makes us receptive to specific data and information in our environment (external context). Among many thousands of stimuli in the external context we only feel, hear, see, smell, taste, and “pay attention to” one stimulus at a time. Attention is direct, distinct, and sudden. New impressions are dependent on and interpreted against the background of our previous experience, learning, and memory, i.e. *our frame of reference*.

The literature on attention and perception is vast and it ranges from fine-grained psycho-physiological work on pre-attentive processes to the more general study of the perception and interpretation of il-

illustration, text, and speech. One of the first problems for the information designer is to gain the attention of people, and thereafter she or he has the continuing problem of holding their attention. 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. Keller and Burkman (1993) noted that it is important to create a positive impression and give courseware a comfortable image to gain and maintain learner attention and to build confidence.

The structure of a text should be as clear as possible. Jonassen (1982) noted that the headings on different hierarchic levels will provide the readers with reference points and help them cognitively organize information for better retention and recall.

Visuals are perceived much more rapidly and readily than text (Fleming & Levie, 1993; Sinatra, 1986). Lester (1995, p. 73) noted that: "Visual messages are a powerful form of communication because they stimulate both intellectual and emotional responses—they make us think as well as feel." Many authors have suggested various roles, functions, objectives and purposes for the use of illustrations—often without a great deal of evidence to support their suggestions.

Hannus (1996) used eye-movement equipment and studied how pupils picked up information while learning from textbooks. He concluded that not enough attention is paid to the illustrations. Thus the learning functions of illustrations were less than he had expected. Many pictures in textbooks remain "unseen" (Reinking, 1986; Weidenmann, 1989; Pettersson, 1990; Peeck, 1993, 1994). Neither teachers, nor students attend to these pictures.

Any warning, and any symbol, must attract attention and be readily understood by the intended audience, the persons who need the information (Dewar & Arthur, 1999). 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. The action to be taken should be immediately obvious. Furthermore the message in the warning must be able to motivate the intended receivers to

comply with the desired behaviour (Wogalter, 1999). Here, colour may be combined with shape and position.

Capacity theories

Attention makes us receptive to specific data and information in our environment. Among the thousands of stimuli in the external context we only feel, hear, see, smell, taste, or “pay attention to” one stimulus at a time. Attention is direct, distinct, and sudden. The sequential flow of attention to the parts of a message is determined by the sequence in which data and information is presented to us. When we attend to something we select that data or information for further processing. Attention can be considered as the activation of groups of brain cells. In any given situation there are always far more stimuli than we can ever notice and transfer to the short-term memory. We have to select the data and the information we want to see or hear and we ignore the rest. Most stimuli remain unknown, unseen, and unheard of.

Filter theory

Broadbent (1958) studied selectivity of attention and he proposed a *filter theory*. According to this theory we are not able to attend to more than one stimulus at a time. Broadbent suggested that while a large amount of sensory information can be absorbed at one time, a selective filter (the attention mechanism) reduces the input from one source while that from another source is being analysed by the brain. Here attention is a limited capacity channel that determines the serial processing of the perceptual system.

Pertinent stimuli theory

We can pay attention to the content of a message, to the execution of that message, to the context in which the message is presented, and to the actual format or medium that carries the message. All of these factors may influence our attention.

The filter theory did not allow for the influence of long-term memory or the meaning of the stimulus. However, subsequent experiments showed that the content of an unattended message may be perceived if

it is relevant. Semantic characteristics of the stimulus affect attention. Deutsch and Deutsch (1963), and Norman (1967) suggested that we analyse all inputs but only attend to pertinent stimuli.

Pre-attentive processing theory

Certain simple shapes or colours “pop out” from their surroundings (Ware, 2000). This is called “pre-attentive processing.” Ware wrote (p. 163): “In essence, pre-attentive processing determines what visual objects are offered up to our attention.” The features that are pre-attentively processed can be organised into categories based on colour, form, motion, and spatial position.

Information materials must get attention, and maintain attention. In order to facilitate attention the information designer should use pictures that are interesting enough for the intended audience. It is a good idea to use different types of visuals, and provide pictures of the human figure, in particular pictures of the face.

Resource models

There are several *attention resource models*, such as a two-process theory, a sudden attention theory, an arousal theory, a multiple resource theory, a misdirecting attention theory, a location and shape theory, an attention time span theory, a colour attention theory, a brightness and movement theory, and a novelty attention theory.

An “attention time span” is the length of time a subject can focus on an object or a topic. Our attention will usually not last for long. Any information material and any presentation must constantly redraw the attention to hold the interest of the viewer.

Colour enhances the attention and perception of a visual message. Our peripheral vision is especially sensitive to brightness and movement, both highly relevant to the detection of any approaching danger. Novelty and whatever stands in contrast to immediate past experience or to life-long experience grabs our attention

For Stern and Robinson (1994) “selection” of sensory data is the first step of perception. However, “selection of data” may also be seen as a part of “attention.”

Perception theories

Perception is a fundamental characteristic of life. In order to continue living, every organism has to perceive its environment, and the changes in this environment. The concept of “perception” is a collective designation for the different processes in which an animal or a person obtains information about the outside world. We organize and analyze information that we have paid attention to. Colours, illustrations, images, lines, pictures, sounds, symbols, texts, and words should be integrated in such a way that they can be interpreted as a meaningful whole rather than a number of individual elements. Perception of two- or three-dimensional representations entails fast, holistic, parallel, and simultaneous processing (e.g. Gazzaniga, 1967; Sperry, 1973, 1982).

Clarity theory

New impressions are dependent on and interpreted against the background of our previous individual experience and learning. Experiences and assessments change over time and affect our way of associating. Messages that are contradictory often create more confusion than they provide help.

It may take only 2–3 seconds to recognize the content in an image (Paivio, 1979; Postman, 1979), but 20–30 seconds to read a verbal description of the same image (Ekwall, 1977; Lawson 1968) and 60–90 seconds to read it aloud (Sinatra, 1986). In verbal and visual languages prior experience and context are very important to the perception of contents.

We do not “see” patches of colours and shades of brightness. We look for, recognize patterns, and combine them into something meaningful. We perceive things, like books, cats, dogs, flowers, houses, people, and trees. We rely on our experiences, thoughts, and values to interpret, understand, and create meaning from what we hear, taste, touch, see, and smell.

The *opponent process theory* and the *tri-chromatic theory* are two complementary theories of colour vision. The opponent process theory, or the *Hering theory*, states that the visual system interprets colour in an antagonistic way: red vs. green, blue vs. yellow, black vs. white. The

tri-chromatic theory, or *Young-Helmholtz theory*, states that the retina's three types of cones are preferentially sensitive to blue, green, and red. These theories describe different stages in visual physiology.

The perception system strives to obtain *clarity*. When the system arrives at clarity, then clarity serves as reinforcement, a reward. Thus an important principle for the designer is to improve *clarity* of any message (Fleming & Levie, 1993; Winn, 1993). As previously noted the *main goal* in information design should always be *clarity of communication*. We should limit the content to what the intended audience needs, and emphasize what is most important. Pictures should be well worth reading for the intended audience.

Barry (1998) made a clear distinction between two *independent mind systems*, one that feels and one that thinks. This explains why images may speak to us holistically and emotionally. Data about some images are only emotionally processed. Other images are analysed. In *rational theory*, people weigh things equally and then consciously decide on truth or logic. In reality, however, emotional response comes first. Barry concluded we begin to respond to the visual environment emotionally, below the level of or rational awareness, before we can critically analyze it. This makes it likely that much of cognition is actually rationalisation to make unconscious emotional response acceptable to the conscious mind.

I have presented a similar “dual view” (Pettersson, 1987) when I found that simple line drawings accompanied by various assignments caused very different reactions in subjects. It is obvious that the different assignments have caused perception and image interpretation on different cognitive levels.

Figure and ground theory

Figure/ground perception is a fundamental aspect of field organization. The Danish psychologist and phenomenologist Edgar John Rubin (1886-1951) presented his work on figure/ground perception 1915/1921 (Palmer, 1999). This was before Max Wertheimer presented his *Gestalt laws* in Germany.

We select some elements in a picture as the *figure*, the object of interest. The remaining parts constitute the *ground* on which the figure rests. This is one of the simplest, but very effective perceptual organizations. The visual system has a strong preference to ascribe the contour to just one of its border regions and to perceive the other side as part of a surface extending behind it (Palmer, 1999).

We perceive the figure as being in front of the ground, and the ground as being behind the figure. We might be tempted to view figure and ground as a relationship between just two levels (Schriver, 1997, p. 307). However, what serves as the ground in one relationship can serve as the figure in another relationship. The figure/ground organization is affected and influenced by several factors, such as: context, contrast, meaningfulness, motion, orientation, parallelism, size, and symmetry.

The context in which a visual message, the actual content, is presented is important for the way the message is perceived. When certain elements are in motion and others are stationary, the moving elements will be perceived as figure elements, and stationary ones will be perceived as ground elements (Lidwell et al., 2010, p. 50). For example, the context may consist of music, other visuals, sound effects, speech, and often the context is printed text. When we view a film or a television programme our attention is on either the image or on the sound. Image and sound cannot be the “figure” at the same time. This is even more obvious when we look at a multi-image slide and film presentation. As soon as the film starts, our attention is directed towards the *movement* in the film, away from the surrounding stills. The surrounding stills become the ground. It is impossible for viewers not to be influenced by this movement.

Sometimes it may be hard to distinguish between figure and ground. Then some structures will be perceived as reversible. Reality and what we see at any given moment will always be separated and different. We will perceive different things at different occasions, both with respect to reality and with respect to pictures. In some cases figure-ground articulation has apparently been based on experience (Peterson & Skow-Grant, 2003).

Miller (2007, p. 11) noted that the animal kingdom is filled with creatures whose colours and patterns help conceal and protect them. The birth of modern military camouflage was a direct consequence of the invention of the aeroplane (Newark, 2007). Members of staff painted bold disruptive patterns on aircrafts, guns, and tanks. In animal camouflage as well as military camouflage objects are perceptually subdivided. Their parts are grouped with parts of the surrounding environment.

Gestalt theories

Early in the 20th century the three psychologists Max Wertheimer (1880-1943), Kurt Koffka (1886-1941) and Wolfgang Köhler (1887-1967) collaborated on the founding of a new holistic attitude toward psychology called *Gestalt psychology*, or *Gestalt theory*. Wertheimer started his research on the gestalt principles of perceptual grouping already in 1910, but he did not formally publish anything about of his work before 1923 (King, 2005).

The essential thesis in *Gestalt psychology* is that in perception *the whole is different from the sum of its parts* (Koffka, 1935; Köhler, 1929; Palmer, 1999; Wertheimer, 1923). There are many Gestalt principles. Each principle is supposed to function, as long as all other things are constant. Sometimes two or even more principles apply to the same grouping of elements. When the principles agree the effect is stronger. When the principles disagree the effect is weaker, and one of them will take over.

The following Gestalt principles provide most opportunities for designers: Closure principle, common fate principle, continuity principle, contrast principle, good form principle, grouping principle, objective set principle, proximity principle, and similarity principle.

The **closure principle** is based on our tendency to perceive complete figures. When a figure, letter, picture, shape, or symbol is incomplete, and parts of its border are missing, our minds will automatically fill in the missing parts and “close” the outline of the structure.

The **common fate principle** is based on our tendency to perceive objects that *move* together in the same direction as collective enti-

ties. We group lines that seem to be moving in the same direction. This phenomenon is common in diagrams and in graphs.

The *continuity principle* is based on our tendency to perceive a slow and gradual change in a stimulus as one single stimulus. We group elements that are aligned into perceptual wholes. It is easier to perceive a smooth continuation of a line than an abrupt shift of direction.

The *contrast principle* is based on our tendency to array impressions that form natural opposites in groups, and reinforcing one another. A certain line seems to be long when it is compared with a shorter line, but it seems to be short when it is compared with a longer line.

The *good form principle* is based on our tendency to perceptually group elements together if they form a pattern that is orderly, regular, and simple. We eliminate complexity and unfamiliarity. When we see a set of elements that can be interpreted in different ways we interpret the elements in the simplest way.

The *grouping principle* is based on our tendency to perceive small elements that are arranged in groups as larger forms. Presence of a boundary is not required for the perception of form or shape. This is similar to “closure.”

The *objective set principle* is based on our tendency to perceive some phenomena more strongly than others. We perceive two lines that almost form a right angle as a right angle. Once we see perceptual units as a stable group, perception will try to retain this group.

The *proximity principle* is based on our tendency to perceptually group events, objects, and units on the basis of their proximity to one another. They “belong together” and they are processed together. The need to process large numbers of small stimuli is reduced, and perception is faster.

The *similarity principle* is based on our tendency to perceive and group our impressions on the basis of their similarity. Events, objects, and units that look alike, and share similar characteristics and properties belong together. It can be qualities like brightness, colour, darkness, orientation, pattern, shape, size, texture, value, or other qualities.

According to Waller (1987) the observations on which the “Gestalt theory” is based form a basic part of the graphic designer’s craft knowledge. The same is valid for the information designer.

Affordance theories

According to Gibson (1977, 1979) we perceive the world both in terms of shapes and spatial relations of objects, as well as possibilities for *action*. Clues and stimuli in objects, as well as qualities of our environment, may potentially generate different actions in a direct and immediate way without any sensory processing. Thus perception can directly result in an action. The action is always within the physical capabilities of the *actor*. The actor can be a person, and also an animal. Gibson called this *affordance* in his *theory of affordances*.

Norman (1988a, 1988b) borrowed the term *affordance* from cognitive psychology and he applied it to the *design* of physical as well as virtual environments and products. Norman made the concept dependent not only on the physical capabilities of an actor, but also dependent on the actor's own beliefs, experiences, goals, plans, and values. The designer of virtual environments and virtual products cares about *perceived affordances*, whether the user perceives that some action actually is possible or not. In product design, where one deals with real, physical objects, there can be both real and perceived affordances.

Some familiar everyday examples of affordance include our natural understanding that buttons are for pushing, cords and handles are for pulling, cylinders are for rolling, knobs are for turning, and switches are for flipping. All these designed objects invite us to act in the intended way. Here action and perception are linked together through real-world objects that provide action possibilities.

The concept affordance has rapidly spread within the fields of human-machine interaction, and interaction design. In graphical, screen-based interfaces, all that the designer has available is control over perceived affordances. In effect Norman's affordances “suggest” how the user may interact with an object.

Day and Lloyd (2007) argued that concepts derived from affordance theories are highly useful in understanding the role of online

technologies in learning. They suggested that the value of this approach is maximised when the focus is moved away from the inherent properties of the technologies to the opportunities for learning provided by the total context in which the technologies are embedded.

Dalgarno and Lee (2010) explored the potential learning benefits of 3-D virtual learning environments. They identified a series of learning affordances of such environments. These affordances include the facilitation of tasks that lead to enhanced spatial knowledge representation, greater opportunities for experiential learning, increased motivation/engagement, improved contextualisation of learning and richer/more effective collaborative learning as compared to tasks made possible by traditional 2-D alternatives.

Waller (2011b) discussed affordance qualities in documents and graphic design. In graphic design affordance may be checklists that afford the correct returning of key documents, contact information that affords the use of the right channels for customer queries, and print summaries that encourage previewing of key contents. In a document we tend to see significance in the way things are aligned, and in their relative prominence.

Today affordance theory has practical implications in a variety of fields such as: artificial intelligence, cognitive psychology, design, distributed cognition, environmental psychology, ergonomics, gaming design, graphic design, human-computer interaction, industrial design, information design, interaction design, instructional design, intelligent learning environments, learning technologies, perceptual psychology, robot technology, science, technology, user-centred design, visualization, and visual literacy.

Processing theories

There is no direct correspondence between groups of letters, words, sentences, paragraphs, texts, and reality. Understanding the concepts that words represent in various specialist areas and sub-cultures may be difficult or even impossible for all non-specialists. Thus the information designer needs to know the audience. In general one can state that information should be as clear, simple, and unambiguous as possible. However, in any presentation, information can be enriched with a wealth of details.

Mental processing is a designation for the mental processes in which we process information into knowledge with reference to our earlier experiences and memories. The information must be internalized and made our property, as part of our memory.

Mental application is a designation for the mental processes in which we make use of our new knowledge and test it in for confirmation. We will remember relevant and meaningful information if we have use for it. Hereby, knowledge is internalized and can influence new attention. In order to facilitate memory the information designer should only present a limited number of information elements with meaningful contents at the same time. It is important to present text and illustrations in close connection.

Previously the *learning styles theory* belonged to this list. According to this theory people will learn more effectively when they receive information in a way that conforms to their personal modalities and preferences (Pashler, et al., 2009). Thus learning should increase when information is presented visually to a visual learner, and auditory to an auditory learner. Since the 1960s the idea of individual learning styles has had a great influence on education, and it has also been included in teacher education and adult education programs in many countries.

There are, however, many opinions with respect to learning styles (Coffield et al., 2004). Some argue that there is a lack of evidence to support the view that matching teaching and learning styles is educationally significant (Geake, 2008; Pashler, et al., 2009). Some argue that the majority of empirical research suggests that the model is not at all accurate (Fridley and Fridley, 2010; Mayer, 2011). *It seems that*

learning styles instruction may have no effect on student learning (Allcock and Hulme, 2010; Choi, Lee, and Kang, 2009).

Schema theory

The British psychologist Frederic Bartlett (1932) used *schemata* (or *schemas*) as a basic concept when he developed his learning theory. Bartlett suggested that a network of abstract *mental structures* form our understanding of the world. In Piaget's theory of development, children adopt a series of schemata to understand the world. A schema is a unit of understanding stored and organized in the long-term memory. A schema contains general expectations and knowledge about events, people, places, and social roles (Rumelhart, 1981; Sinatra, 1986). In cognitive science and psychology, a schema describes an *organized pattern* of behaviour or thought. A schema is a cognitive framework or concept that helps organize categories of information and the relationships among them. We use genres, prototypes and our *mental schemata* in communication (Bondebjerg, 1994; Höijer, 1992a, 1992b).

Schema theory describes how knowledge is acquired, processed and organized. The focus is on how we assign meaning to things through social experience (Davis, 2012, p. 80). We use schemata to organize current knowledge and provide a framework for future understanding. We are more likely to notice things that fit into our already existing schemata. Our schemata are constantly refreshed and restructured through new knowledge, while additional connections among related schemata are made. We build new concepts on the foundation of older ones. However, schemata can also contribute to stereotypes and make it difficult to retain new information that does not conform to our established ideas about the world.

The schemata that we use when we read influence our deeper understanding of the content in the text (Gunnarsson, 1982). The reading procedure is of great importance to our capacity for understanding. In “normal reading,” we direct our attention towards how we shall interpret the meaning of a sentence. Studying the syntax becomes subordinate to orienting our thoughts amid the semantic and pragmatic relationships that form the text's warp and woof. When we read long con-

tinuous texts, we process separate sentences with an eye to their integration into the material's entirety. This takes place gradually, with the text that we have already read providing the framework. The connection makes sense of the text.

Learning from reading text is affected in the same way as comprehension. What we can recall is typically related to how well we understood it in the first place. Rouet et al. (1995) noted that although a large number of studies have been devoted to the cognitive processing of single text passages, far less is known about the comprehension process in using multiple documents for learning. In two studies they found that 11th grade students' knowledge increased after reading multiple history documents on the same subject.

Conceptual change theory

Concepts are mental representations corresponding to words. For example, the concept "tree" is a mental structure that corresponds to the word "tree" and refers to trees in the world. Concepts may also represent a set of ideas that can be described by a few words. Several concepts can act as building blocks of more complex or even abstract representations.

The terms "conceptual change," "conceptual change model" (CCM), and "conceptual change theory" can be seen as the mental processes that alter our understandings of concepts, as well as the relationships between them, in content and organization. Initially the idea of conceptual change was used in education as a way of thinking about the learning, and re-learning, of changing meanings of important concepts in disciplines such as physics (Posner et al., 1982) and biology (Carey, 1985).

Hewson (1981, 1982) expanded the idea of conceptual change from biology and physics to other disciplines. Today the study of conceptual change is an interdisciplinary field. It is often discussed in teaching of science and technology. In these disciplines students cannot rely on simple memorization of facts in order to understand advanced concepts. Here students must learn to restructure their intuitive knowledge based on culture and experience. Because conceptual change is needed

teachers must find ways to enhance the motivation of individual students. According to Jonassen (2006) conceptual change is the mechanism underlying meaningful learning. According to diSessa (2008) the central principle of conceptual change research is the constructivist idea that old ideas (or mental structures) are influential in supporting or constraining learning (or development).

Since the mental construction processes are influenced by a variety of social experiences, Hewson (1992) argued that knowledge constructed by each individual is not normally completely idiosyncratic and personal. Existing knowledge and cultural and social agreements about meaning not only limit how new experiences are interpreted, but also influence what is perceived in any situation. Thus, two individuals exposed to the same events may perceive and interpret them in very different ways. This depends on their individual underlying beliefs and knowledge, and the ways in which these beliefs influence and are influenced by the social interactions out of which they are formed.

Özdemir and Clark (2007) concluded that a body of conceptual change researchers have made significant progress on two competing theoretical perspectives regarding knowledge structure coherence: 1) Knowledge-as-theory perspectives, and 2) Knowledge-as-elements perspectives.

Conceptual change through “knowledge-as-theory” was derived from the work of Piaget’s learning theory and Kuhn’s concept of normal science and scientific revolution. This perspective was summarized in the following question: “Is a student’s knowledge most accurately represented as a coherent unified framework of theory-like character?”

Conceptual change through “knowledge-as-elements” recognizes a student’s understanding of material through their interaction with the world. This perspective was summarized in the following question: “Is a student’s knowledge more aptly considered as an ecology of quasi-independent elements?”

These two perspectives implicate radically different pathways for curricular design to help students reorganize their understandings. There are significant similarities and differences between knowledge-as-theory and knowledge-as-elements perspectives. If a learner’s

understanding is theory-like, and if certain specific conditions are met, the learner will become dissatisfied with existing conceptions when conflicting examples are introduced to the learner. If a learner's intuitive knowledge is elemental in nature, instruction should focus on how those elements are activated in appropriate contexts. From a constructivist view, all of the various elements in a student's conceptual network are subject to progressive knowledge construction.

Vosniadou (2007) proposed a conceptual change model for iconic and symbolic visual representations existing in a learner's schema structures. Here mental representations are held together in an organized fashion. This allows people to understand how different pieces may be related, and how they may influence each other. The "Vosniadou conceptual change model" has five interconnected key components in a three-dimensional structure. These components are: 1) Framework theories, 2) Presuppositions, 3) Conceptual domains, 4) Concepts, and 5) Specific theories.

According to the *framework theories* already existing knowledge will influence how a learner may understand new information. Visual data may be used in science instruction and learning. Framework theories are large overarching sets of knowledge. These structures frame learner understanding and serve the learner as lenses through which he/she "sees" knowledge (Finson & Pedersen, 2015).

At any single instant, a learner may hold multiple framework theories. A learner's framework theories include his/her intuitive knowledge, knowledge gained from life experiences, and beliefs. The learner presumes that some information is accurate, and applicable to the situation. *Presuppositions* act as filters for the transfer of information into schemata, and may therefore effectively hinder alternative explanations. Examples of presuppositions: 1) Visual data may be used as effective tools. 2) Visual data are limited and cannot be used in all learning contexts.

A *conceptual domain* is a coherent body of knowledge. The learner may use knowledge from several different domains. A conceptual domain will include many concepts. Conceptual domains may concern the function of the brain and the cognitive building of schemas.

A *concept* is a small piece of subject matter knowledge. Several related pieces are used together as *units*. Examples of concepts are visual perception, visual learning, and visual thinking.

Sets of interrelated propositions form specific theories. *Specific theories* are influenced by attitudes, cultural contexts, social contexts, and motivations. Examples of specific theories concern various aspects of areas such as cognition, learning, and visual literacy.

This framework may guide science educators in making more effective use of “visual data” in instructional contexts. Vosniadou defined *visual data* as visual inputs beyond visual information.

Wayfinding and wayshowing

In order to describe his concept of *environmental legibility* Lynch (1960) coined the term “wayfinding” in his book *The Image of the City*. This new concept included the elements of the built environment that allow people to successfully navigate through complex spaces like cities and towns.

Passini (1984) and Arthur and Passini (1992) discussed the concept *wayfinding* in more detail. It refers to the cognitive and behavioural abilities that are associated with how individuals can purposefully reach a desired physical destination (Passini, 1999, p. 88). A good “wayfinding system” allows people to reach their desired destination easily and quickly with as few mistakes as possible.

In terms of “problem solving” wayfinding comprises three major processes: 1) Decision making and the development of a plan of action to reach a desired destination. 2) Decision execution and transforming the plan of action into behaviour of the appropriate place(s) along a route. 3) Perception and cognition, and providing the necessary information to make and execute decisions.

Wayfinding is distinguished from other types of problem solving by operating in an architectural, geographic, or urban space. In this context “cognitive maps” are parts of information processing. Arthur and Passini (2002) have further developed the “wayfinding concept” and how people search through information loaded environments.

Wayfinding is a term commonly used by designers and manufacturers of signs and signage systems. Mollerup (2005) pointed out that some of them may actually work with wayfinding. However, they have not found their way to precise language. In their work as “sign writers”, they should actually work with the different possibilities to “show the way”. Such messages must be accurately developed and transmitted by the information providers and then correctly interpreted and understood by the receivers or interpreters.

Actually “finding the way” is the responsibility for those individuals who need to find their way in order to go somewhere. According to Mollerup (2005) wayshowing relates to wayfinding as writing relates to reading and as speaking relates to hearing. *The purpose of wayshowing is to facilitate wayfinding.* Wayshowing is the means. Wayfinding is the end. The introduction of the term *wayshowing* is an important contribution to information design.

Psychological information theory

The *psychological information theory* is one of the main branches of cognitive psychology. It evolved out of the American experimental tradition in psychology (Miller, 2003). Psychological information theory refers to the study of man’s mental information processing of text, pictures and other representations (Gray and Bjorklund, 2014). According to this theory humans process the information they actually receive, rather than merely respond to stimuli. The cognitive processes in the brain may be seen as a flow of information between different memory functions. Here, the mind is compared with a computer that is analyzing information from the environment. There is an idea of a continuous pattern of development.

Constructivist learning theory

One way of viewing memory functions is based on information processing in steps (Atkinson & Shiffrin, 1968). This is the “*information processing theory.*” The first of these steps is the *sensory memory*, or the immediate memory, which carries out the storage of stimulus information at the peripheral level. After being processed in the sensory mem-

ory, some information is passed on to the *short-term memory* (STM), also called operative memory, and working memory. The third step is the *long-term memory* (LTM).

Reality is in the mind of the learner. The basis of the *constructivist learning theory* is an active individual, an active learner. Constructivism is grounded in the philosophy of Dewey, Kant, and Vico, and the psychology of Piaget, Bruner, and Bartlett. In constructivism knowledge is a function of how individuals create and construct meaning from their own experiences and their own physical and social context and environment. The learner is the central focus in the constructivism model, not the instructor or the teacher.

According to Jonassen (1991, p. 10) each individual creates meaning from his or her own experiences. Ertmer and Newby, (1993, p. 66) put it this way:

As one moves along the behaviourist - cognitivist - constructivist continuum, the focus of instruction shifts from teaching to learning, from the passive transfer of facts and routines to the active application of ideas to problems.

The *cognitive constructivist* approach focuses on the individual, and her or his construction of knowledge. The *social constructivist* focus on the social and cultural processes that affect the individual with learning as a result.

The information age and the technological capabilities have caused us to design new instructional approaches (Duffy & Jonassen, 1992). Media producers construct their messages. Media show us different versions of reality.

Facilitating mental processing is one of the *cognitive principles* in information design (Pettersson, 2010). There is no direct correspondence between groups of letters, words, sentences, paragraphs, texts, and reality. Understanding the concepts that words represent in various specialist areas and sub-cultures may be difficult or even impossible for all non-specialists. Thus the information designer needs to know the audience. In general one can state that information should be as simple, clear, and unambiguous as possible.

Action theory

Based upon a “theory of action” Argyris (1976), and Argyris and Schön (1974, 1978), discussed an *action theory*, also called *double loop learning theory*. Here, the focus is on solving problems that are complex and badly structured. It is necessary to change underlying values and assumptions. An important aspect is the distinction between what individuals think and what individuals actually do.

Double loop learning is a theory of personal change that is oriented towards professional education, especially related to leadership in organizations. In double loop learning, assumptions underlying current views are questioned and hypotheses about behaviour are tested publicly. The end result of double loop learning should be increased effectiveness in decision-making and better acceptance of failures and mistakes.

Swieringa and Wierdsma (1992) developed the *collective loop learning theory*. Collective learning means organisational changes. At the level of *single loop learning* this applies to changes in the rules, the agreements on how we collaborate, what we must do or what we are allowed to do within the present system. This may only result in a number of minor improvements. With double-loop-learning people bring the shared insights forming the basis of the rules into play. Now people will learn new principles. This means opinions, reasoning, and theories. The double loop learning may result in renewal of the processes or renewal of the structures in the organisation. The *triple loop learning* theory applies to changes in the communally shared principles on which the organisation is based. It represents collective learning at the level of courage and will, and it results in development and major changes of the behaviour of the organisation.

Dual coding theory

The *dual-code memory model*, or the *dual coding theory*, proposes that rather than just one sensory memory, one short-term memory, and long-term memory, as might be implied in information processing theory, there are actually separate memory systems for different types of information. We have a *verbal system* for processing and storing lin-

guistic information and a separate *non-verbal system* for spatial information and mental imagery (Paivio, 1971, 1978, 1983, 1990).

These systems can function independently, but are also interconnected. According to Winn (1993) it is generally agreed that information presented in pictures is encoded twice, once as a picture and once as a verbal label that names the picture. Information can be retrieved either from the pictorial or from the verbal memory (Clark and Paivio, 1991; Di Virgilio & Clarke, 1997; Hodes, 1998; Kulhavy et al., 1985; Paivio, 1971, 1983; Paivio, Walsh, & Bons, 1994; Sadoski, Goetz, & Avila, 1995; Schwartz, 1988). The dual coding theory predicts that all learners, regardless of their modality, will learn best when they receive combined verbal and visual messages.

Mayer and Moreno (1998), and Mayer (2000) have been interested in how verbal and visual memories interact. They focus on facilitating memory. Memory is greater when a verbal and a visual code are activated at the same time, rather than only one of them. The image is centrally important in facilitating long-term retention, at least for adults (Paivio, 1983, 1986, 1991). It is also known that our memory for pictures is superior to our memory for words (Adams & Chambers 1962; Haber & Myers, 1982). This is called the *pictorial superiority effect* (Paivio, 1983; Branch & Bloom, 1995). Careful integration of words and pictures engage people more effectively than words or pictures alone (Sadoski & Paivio, 2001).

According to Klatzky (1980) dual-code theorists have accepted the idea that mental images are not exact copies of external pictures. Instead mental images contain information that was encoded after perceptual analysis and pattern recognition. In accordance with Anderson (1978) images are organized into sub-pictures at the time of perception. Paivio (1986) further explained that mental representations have their developmental beginnings in perceptual, motor, and affective experience and are able to retain these characteristics when being encoded so that the structures and the processes are modality specific.

Practical application theories

This group includes theories on how to apply knowledge of attention, perception, and systems for mental processing in the production of information sets and learning materials.

Design of teaching aids

Professor Andreas Vesalius (1514–1564) is an early example of a person engaged in advanced and skilled graphic presentation. He revolutionized the study of biology and the practice of medicine by his careful verbal and visual descriptions of the anatomy of the human body. He systematically built up a considerable knowledge of the anatomy of the human male body and he wrote the first comprehensive textbook of human anatomy, *De humani corporis fabrica libri septem* (On the Fabric of the Human Body in Seven Volumes).

On the basis of Vesalius' own drawings Johann Stephan van Calcar (1499-1546 or 1550) and other students in Titian's Venetian workshop, drew artistically masterful anatomical illustrations (Lindberg 1997, p. 113). In Basel Vesalius and the humanist printer Johannes Oporinus (1507–1568) worked together with layout, typography, and quality control. Oporinus printed the *Fabrica* in 1543 in a deluxe folio format (17 5/8" × 11 3/8"; approximately 43 x 28 cm). The *Fabrica* consisted of 663 pages and 83 plates containing 430 illustrations. The 300 woodcuts in the book were probably based on illustrations made by Johann Stephan van Calcar and other artists in the studio of Titian. Some illustrations were printed with engraved copper plates (Hassner, 1977 p. 32). This book fulfilled an important role as a reference tool in medical science for two centuries.

Iohannes Amos Comenius (1592–1670) was the first person to really show to a broader audience how visuals and words could interplay in an active way. Comenius formulated a *general theory of education* (Heinich et al. 1993). *Didactica Magna* (Great Didactic) is a large treatise on education. It was first published 1627 in Czech. It was later extended and translated in Latin. This version was published in 1657 with the title *Opera Didactica Omnia*. The book contained his educational goals, philosophy and principles. This philosophy presented the

goal of education as the development of universal knowledge among all people of all social classes in all nations, including women and children.

To facilitate learning, teachers should use pictures showing other events than those children have in their immediate vicinity, and therefore can easily observe themselves. Comenius' illustrated textbook, *Orbis Sensualium Pictus* (The Visible World in Pictures), was first published in 1658. This book may be the most renowned and most widely circulated of school textbooks. Here Comenius presented information on the world and on mankind in *closely related pictures and words*. Through 150 illustrated chapters the book was designed to teach the pupil Latin with the help of short, but memorable sentences. This book was widely used in both Europe and the USA for some 200 years.

Underlying Comenius's use of visuals was a theory of perception based on the idea that we learn through our senses and that this learning "imprints" a mental image that leads to understanding. Real objects are preferable, but visuals may be used as substitutes for them.

Comenius' conclusion, that nonverbal communication between parent and child both precedes and forms the basis of later language acquisition and development, is still considered a sound tenet of the theory of visual language (e.g. Heinich et al., 1993; Sinatra, 1986; Moriarty, 1994). Moriarty noted that (p. 15): "Child development scholars would agree that visual communication skills are not secondary, derivative, impure or peripheral and, in fact, develop earlier than verbal skills in children." As I see it Comenius was a pioneer in information design.

When Adams and Chambers (1962) simultaneously presented auditory and visual stimuli results revealed a net superiority of bi-sensory over uni-sensory responding when stimulus events were certain. Information that is shared between sensory channels will facilitate learning. Cues that occur simultaneously in auditory and visual channels are likely to be better recalled from memory than those cues presented in one channel only.

Levie and Lentz (1982) found that conveying information through both verbal and visual languages makes it possible for learners to alternate between functionally independent, though interconnected, and complementary cognitive processing systems.

Mayer et al. (1995) built a theory of meaningful learning from components of the *generative learning theory* (Wittrock, 1974, 1989) and the *dual coding theory* (Clark & Paivio, 1991; Paivio, 1971, 1978, 1983, 1986, 1991). In this “*generative theory of textbook design*” learning is viewed as a constructive process.

In three experiments Mayer et al. (1995) compared college students' solutions on transfer problems after reading science texts with illustrations adjacent to corresponding text and including annotations, and illustrations separated from text without annotations. The experiments showed that learners select verbal and visual information and build cognitive connections from different pieces of knowledge. Information is moved from sensory memory to short-term memory. Selected bits of information are stored in a “text base,” and in an “image base” respectively. Then learners build connections between verbal and visual representations. This is best done when the text and the 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, or when learners have sufficient experience to generate their own mental images as they read the text.

Mayer et al. (1995) interpreted the results in light of the generative theory of multimedia learning. This theory posits that meaningful learning requires constructing connections between visual and verbal representations of a system.

Cognitive theory of multimedia learning

Multimedia explanations allow students to work easily with verbal and non-verbal representations of complex systems. Based on the dual coding theory, the cognitive load theory, and the constructivist learning theory (Mayer, 1997) proposed a *cognitive theory of multimedia learning*, and argued that active learning occurs when a learner engages three cognitive processes: 1) Selecting relevant words for verbal processing, 2) Selecting relevant images for visual processing, and 3) Organizing words into a coherent verbal model and organizing images into a coherent visual model, integrating corresponding components of

the verbal and visual models. Moreno and Mayer (2000) presented six *instructional design* principles for this theory.

- *Split-attention principle*: “Students learn better when the instructional material does not require them to split their attention between multiple sources of mutually referring information.”
- *Modality principle*: “Students learn better when the verbal information is presented auditorily as speech than visually as on-screen text both for concurrent and sequential presentations.”
- *Redundancy principle*: “Students learn better from animation and narration than from animation, narration, and text if the visual information is presented simultaneously to the verbal information.”
- *Spatial contiguity principle*: “Students learn better when on-screen text and visual materials are physically integrated rather than separated.”
- *Temporal contiguity principle*: “Students learn better when verbal and visual materials are temporally synchronized rather than separated in time.”
- *Coherence principle*: “Students learn better when extraneous material is excluded rather than included in multimedia explanations.”

Moreno and Mayer (2000) concluded that presenting a verbal explanation of how a system works with an animation does not insure that students will understand the explanation unless research-based principles are applied to the design. Multimedia presentations should not contain too much extraneous information in the form of sounds or words.

Mayer (2009, p. 59) defined learning as a “change in knowledge attributable to experience.” Learning is internal and personal and it cannot be directly observed. It must be inferred through a change in behaviour. People construct knowledge in meaningful ways when they pay attention to the relevant material, organize it into a coherent mental structure, and integrate it with their prior knowledge (Mayer, 1996, 1997, 1999).

However, according to Koumi (2013, p. 102) the cognitive theory of multimedia learning with its six principles exemplify the mismatch be-

tween the research literature and the concerns of practitioners who are actually producing multimedia packages. The principles are “too all embracing.” For example the split-attention effect leads to the either/or recommendation that audio text is always superior to screen text. Sadoski (2006) concluded that the use of graphics, pictures, and videos with matching text is effective in learning especially with multimedia formats.

According to Koumi (2013, p. 89): “UK Open University multimedia packages are typically produced over several script conferences by a team of experienced teachers who know their target audience well.” Over time such a team develops a *tacit, intuitive design model*. In his article Koumi: “seeks to pull together these tacit design models and make them explicit.” He offered forty detailed, usable micro-level, design guidelines for design of pedagogic harmony between spoken commentary (oral text), visual texts (text displayed on the screen), and images in multimedia packages.

Art and Aesthetic disciplines

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

It seems that many believe 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.

Usually *aesthetics* is regarded as a branch of philosophy, along with epistemology, ethics, logic, and metaphysics. Aesthetics is the youngest branch of philosophy with its own name. It 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 proportion principle

Basically proportion is a mathematical concept. However, the concept *aesthetic proportion principle* is a subjective concept. It is related to the appropriate and pleasing relations between elements in information materials.

We may all have different ideas of what we find beautiful and rewarding, and what we find boring, distracting, disturbing, or ugly. When a design is *out of proportion* it is lacking appropriate relations. It may be disproportionate, exaggerated or overemphasized. The information designer may find out receiver preferences of aesthetic proportions. He or she should be careful using proportions according to the *golden section*, and never mix a decorative use of colour with cognitive importance.

Aesthetic designs are perceived as easier to use than less-aesthetic designs (Lidwell et al., 2010, p. 20). The aesthetic proportion principle is one of the two aesthetic principles in information design.

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 adornments, commemorations, religious devotions, 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 in different places, and during different periods. 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 the classical formats are based on the *divine proportion* or the principle of the *golden ratio*. The divine proportion is an irrational

number 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 is 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 about 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 approximation 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 (e.g. Arnheim, 1974; Berndal & Frigyes, 1990; Bringhurst, 2004; Moriarty, 1991). 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.

Information aesthetics

Norman (2002) argued that *visual attractiveness* is important for the cognitive domain since the affective domain is highly related to human cogitation, our action of thinking deeply about something.

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).

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.

Aesthetic value

Aesthetic value is a subjective judgment of value based on the appearance of an object and the emotional responses it evokes. This is difficult to assess objectively. The aesthetic value of a message is how the intended receivers perceive the message with respect to its beauty. With the invention of the printing press the publisher or art director, as previously noted, employed assistants to design typefaces for high aesthetic value and good legibility (Meggs, 2005). More care could be given to graphic design, illustrations and typography. Aesthetic and artistic values of each historical period have been dominating in traditional graphic design. Metallinos (1990) developed a schema that explains three forms of picture presentations in accordance with their *functional aesthetic value*.

Dwyer & Dwyer (1989), however, found that aesthetically pleasing visuals might not be of great instructional value (p. 122): “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.” And Holmes (1993) argued that it is

possible that aesthetically pleasing information material will be noticed and because of that used better than material without any 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.

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 as 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.

The format index can be used to compare pictures and projected images (as a *picture format index*). For the movie format Cinemascope the index is 43, for Showscan 46, for Vistavision Europe 54, Cinema U and IMAX 69, and for a standard film the index is 75. For the effective picture area of a projected slide in Europe the index is 65, for PP 75, and for an OH 78. The image area on a horizontally held iPad Air2 has index 75, and when the iPad 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 a study of design of “harmonious book pages” design students in Sweden and USA were asked to fold a large, white paper to a book page that they felt was the most harmonious (Pettersson & Strand, 2006). The results showed a large variety. On average the most harmonious book page was 22.7 cm high and 16.6 cm wide. This ratio is close to regular office paper. The study showed no significant differences in values of female and male subjects, or by subjects in the two countries. It was concluded in this study that the golden ratio is *not a good principle* when it comes to design of book pages.

Beauty theories

Philosophers have made many 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.

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*.

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.

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.

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.

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. In newspapers attractive information graphics, with “infotainment” values, attract more readers (Holmes, 1993).

Information design may vary a lot in style and quality. 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 *chart-junk* 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 such as: 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 examples 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.

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.

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.

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 spiri-

tually possessed or owned by anyone else, even though the physical ownership of artefacts as well as copyrights can be transferred or sold.

Art and design

According to Mullet and Sano (1995, p. 8) art is valued 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. 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.

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.

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

Aesthetic experiences in instructional design

In 1934 the American educational reformer John Dewey (1859–1952) argued that aesthetics is a quality of experience that “possesses internal integration and fulfilment” (Dewey, 2005, 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). In many design disciplines aesthetic aspects are of high importance to both designers and end-users.

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.

Interface design

Dreilinger (1993, p. 6) wrote about aesthetics and usability 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. In accordance with Baggerman (2000, p. 69) the first rule of *interface design* is “communicating with the user.”

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.

Harmony principle

The *harmony principle* is one of the two aesthetic principles in information design. 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. Other design elements may be distracting and look ugly. There is harmony in information materials when all design elements fit well together and form harmonious relationships. The information designer should develop and use standard templates for graphic design. It is important to find a 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 together. In accordance with Dreilinger (1993) aesthetics and usability are the yin and yang of interface design. Harmony is often closely related to *unity* (Wileman, 1993).

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 credibility and quality.

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

Contrast in typography may be achieved by using different colours, fonts, sizes, and styles. It is far too common with improper contrast. 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 too small type. Text must always 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 horizontals and the verticals, the darks and the 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 quite 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 among other options. However, imbalance and inconsistent use of colours, graphics, and typography, have all been found to reduce learning (Bradshaw, 1996, 2003).

Colour theories

People have probably always seen colour as important. There are rich deposits from 100,000–70,000 years ago in the *Blombos Cave* in South Africa (Henshilwood et al. 2009). Here pieces of red ochre have been deliberately engraved or incised with abstract geometric designs. These artefacts 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.

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 *col-*

our 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.

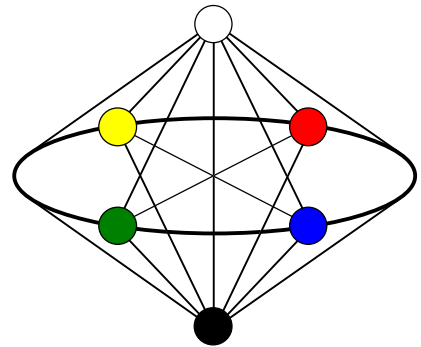
The Natural Colour System

In 1892 the German physiologist Ewald Hering based his “natural system” on man’s natural perception of colour. Hering’s *opponent colour theory* presupposes two pairs of chromatic colours blocking each other,

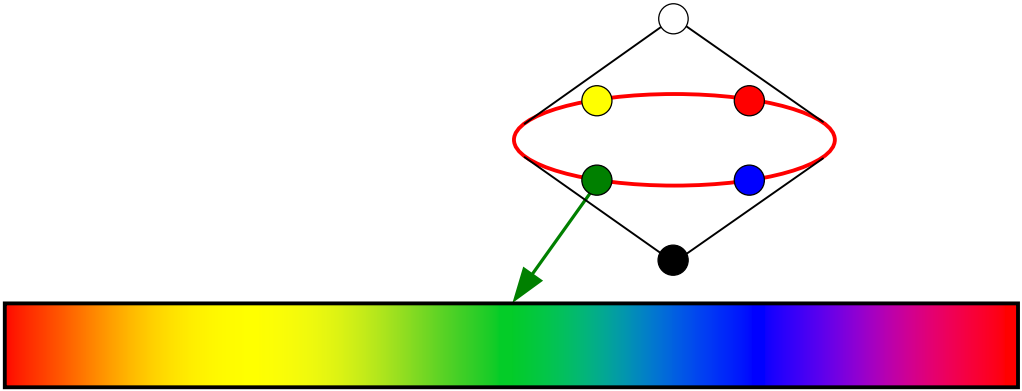
red/green and blue/yellow. This theory became the basis for the *Natural Colour System* (NCS), developed during the 1970s in the Swedish Colour Center Foundation in Stockholm (Hård & Sivik, 1981).

From a perceptual point of view, we perceive six colours as “pure.” Black and white are *achromatic colours*. Yellow, red, blue, and green are pure *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.

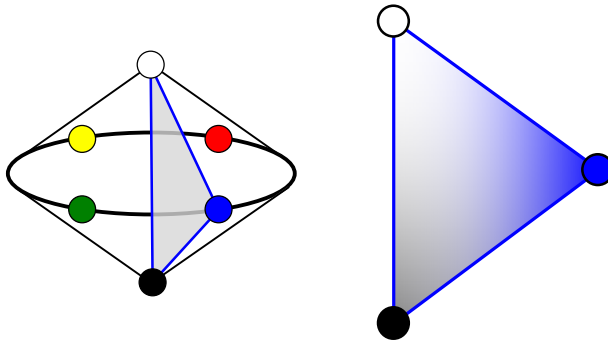


The chromatic elementary colours yellow, red, blue, and green are all located on the circumference of the *Colour Circle*. One hundred steps, thus describing the hue of a colour, can divide each quadrant.



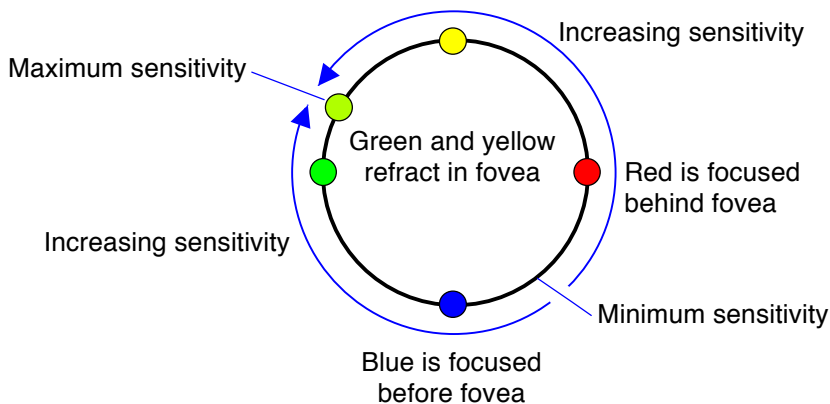
This figure illustrates a cut and opened circumference of the colour circle, here starting with red and ending with red.

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 *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, Thomas Young (1873–1829) proposed a tri-chromatic colour vision system. In 1924, Young's theory was formalized by Herman von Helmholtz (1821–1894), 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, and cyan as subtractive primaries. Colour scientists often use the *additive primaries*, red, green and blue.

In visual displays the colour stimuli are specified by *Red, Green, Blue* (RGB) values as discussed above. 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 defined 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 (Moriarty, 1991).

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, 1978; Hannafin & Peck, 1988; Lipton, 2007; Moriarty, 1991; Muter & Marrutto, 1991; Pettersson, 1989; Scharff, Hill & Ahumada, 2000; Winn, 1993; Wogalter, 1999).

To avoid confusion and misunderstanding, it is important that colour be used consistently. 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.

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 are used for decoration, and when the use is meant to have some cognitive importance.

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