

Information Design

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Information Design: An introduction
by Rune Pettersson

Information Design

An introduction

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Preface

Information Design – An Introduction is a basic textbook for information designers, technical writers and others who want to produce information sets and learning materials. We need many *information utility goods* in order to perform our tasks at work. We also need an increasing amount of information materials during our leisure time, in order to be able to handle things like cameras, cars, CD-players, computers, computer software, etc. A well designed information material makes everyday life easier for people, and it grants good credibility to the senders or sources.

Information design can be hard to define, and often goes by other names. In my view information design may be described in the following way:

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 set will satisfy aesthetic, economic, ergonomic, as well as subject matter requirements.

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

The goal of communication-oriented design of messages should always be *clarity of communication*. In information design the task of the sender or source is actually not completed until the receivers or interpreters have received and understood the intended message.

Information Design – An Introduction includes five chapters: (1) Message design, (2) Text design, (3) Image design, (4) Graphic design, and (5) Cognition. Areas like audio design, exhibition design, event design, light design, time design as well as modern web design are not included in this book. The chapters in this textbook can be seen as a general framework for production of information materials. Based on theories for verbo-visual communication and principles for

message design, design processes, and design tools this textbook presents several practical guidelines for the use of words, symbols, visuals, typography and layout. I hope that these guidelines, will be helpful for the readers.

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CHAPTER 1

Message design

In order to satisfy the information needs of the intended receivers message design comprises analysis, planning, presentation and understanding of messages – their content, language and form. Regardless of the selected medium, a well designed information set will satisfy aesthetic, economic, ergonomic, as well as subject matter requirements. Information design is a multi-disciplinary, multi-dimensional and worldwide consideration with influences from areas such as language, art and aesthetics, information, communication, behaviour and cognition, business and law, as well as media production technologies.

The amount of available messages and information is seen as increasing every day. We need to be able to define, create, produce, distribute, sort, store, search, locate, access, interpret, process, understand, evaluate, use, and revise information.

1.1 Information disciplines

The term *information* is derived from the Latin noun *informatio* which means a conception or an idea. Information has therefore long been synonymous with

1. data, details, facts, and intelligence.
However, the term information has acquired additional meanings. Today it may also refer to
2. the import ascribed to specific data. Then information does not arise until the received data, e.g., a text or a picture, are interpreted by the receiver for formation or moulding of the mind. The term information is also sometimes used for
3. data processed in a computer. Yet another meaning
4. is “an internal structure which regulates processes”. The latter meaning is used in computer science and in genetics. According to *The new Shorter Oxford English Dictionary on Historical Principles* (Brown 1993:1364) the term information can also be used for
5. a formal written statement or accusation,
6. the action of informing against a person; and
7. the giving of a form or essential character to something; inspiration.

The verb *inform* means to supply or convey information or to provide knowledge of something and is therefore an unidirectional process, e.g., from one person to another. In my view, to *communicate* entails an interplay between two or more persons. Thus 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, and linguistic dimensions, whereas others possess hard, technological dimensions. Some subject fields have been well-established for many years. Others are relatively new. In several instances, there is some overlapping because certain sub-issues are addressed in different disciplines, even if the approaches may vary.

Computer science comprises research on the principles for construction, operation, programming and applications of computers. A special focus is on computer software, and analysis of instructions and information needed to solve formalized problems. Practical applications are seen in the development of various computer-aided systems, such as computer-aided software engineering.

Human computer interaction (HCI) comprises research on the design of computer systems that support people so that they can carry out their activities and tasks productively and safely. HCI has a role in the design and development of all kinds of man – machine systems. Safety aspects are very important in the design of control systems for air traffic and nuclear plants. High productivity and job satisfaction are issues in office systems. Entertainment and fun are key concepts in the design of computer games. Interactive information systems are needed in all these cases.

Information design (ID) comprises research on the principles for analysis, planning, presentation and understanding of messages – their contents, language and form. Regardless of the selected medium, a well designed information set will satisfy aesthetic, economic, ergonomic, as well as subject matter requirements.

Information economics comprises research on the business development of information industries. There are a lot of information jobs in all kinds of workplaces, and an increasing number of employees are working with information. Other areas of research are the impact of information and communication, the application of information technology in the work-place, the history and geography of information labour and capital, the regulation and provision of information infrastructure, and the use of computers and networks.

Information ergonomics (IE) comprises research and development of the ergonomic design of man-machine systems. The design of an information system must be based on studies of the information user's aims, knowledge, experience, and way of working. Tasks making particularly heavy information demands occur in work at computer terminals, work at complex information panels, and in signal systems (e.g., for the monitoring of industrial processes and various advanced

tools). Information ergonomics include lighting, the design of instrument panels, video display units, characters, symbols, signals, etc.

Information management (IM) comprises research and development of management and use of information in organisations. Information is divided in small units, sometimes called *information elements*. These elements are linked to objects and can be managed in computer systems, information management systems (IMS). An information element may be a paragraph of text, a list, a table, a symbol or a picture. Sometimes these elements are called *information modules*.

Information processing comprises the processing of information so as to yield new or more useful information. Researchers use mathematical and numerical analysis plus methods and techniques for administrative data processing. The discipline also comprises the study of information searches in databases, information systems, computer aided translation, computer aided education, computer aided problem solving, computer aided design, etc. The term information processing is often used as a synonym for data processing, i.e., the execution of a systematic series of operations on data. The term is also sometimes used for studies of the way people process information mentally.

Information retrieval (IR) comprises actions, methods, and procedures for tracing of data and information stored in computers, archives, libraries, etc. in order to provide information on a given subject. Information retrieval is also a part of information science, but is sometimes considered a research area of its own.

Information science, or *library and information science* (LIS), comprises the study of information in general, and storage of information with sub-areas like classification, indexing, cataloguing, and bibliographic and other databases. 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, collections, circulation as well as scientific communication, use of information, and management of information resources.

Information systems (IS) comprises studies on development, use, and evaluation of computer-based information systems in various kinds of organisations. The social context where these systems are used are important areas of research. Introduction of new information systems usually cause changes in the traditional work processes as well as reorganisation of the administrative routines and the actual organisations.

Information technology (IT) comprises research and development of the technical systems used for making production, distribution, storage, and other information handling more efficient. This includes computer technology and electronics. The term *information society* is sometimes used within information technology. This is a designation for the society which follows after an industrial soci-

ety and in which man's thinking power is supported by information processing computer systems and modern techniques for telecommunications. The information society is dominated by the resource information instead of the traditional resources energy, raw materials, labour, and capital.

Information theory comprises quantitative measurement of transmitted information and comparison of various communications systems, especially in telecommunications. Here the meaning of the messages lack inherent interest. Information theory is based on a mathematical theory presented in the 1940s by the American mathematician Claude E. Shannon. It subsequently came to be known as the "Shannon and Weaver mathematical communications model". In this kind of communications system, a sender (e.g., equipment such as a telex unit) communicates with one or more receivers (other telex units) via a channel. The sender codes the transmitted signal, and the receiver decodes the received signal. Information theory utilizes the *bit* as the smallest unit of information. A bit can either be a one or a zero, representing, e.g., yes/no or on/off. The Shannon and Weaver communications theory has also been used as a model for communications between people.

Media and communication is a wide area of research. At universities in Sweden media and communication studies take an interest in research on mediated communication, in contrast to research on personal communication which is common in many other countries. Mediated communication comprises the study of the communication processes, including the technical production of media. A few years ago the main focus was on the senders, who wanted to reach out with their messages to large groups of receivers in *mass-communication*. These messages were mainly intended to provide entertainment, information and news, and to some extent also advertising and propaganda. Today it is more common in media and communication studies to focus on the individual receivers, their individual interpretations of the varying messages, and the subsequent constructions of meaning made by the receivers.

Planned communication, or *persuasive communication*, comprises studies on advertising, propaganda, and other carefully planned information activities. Here the goal is related to some kind of change in the behaviour of the receivers. Receivers are typically asked to do something.

Psychological information theory is the designation for one of the main branches of cognitive psychology. It refers to the study of man's *mental information processing* of text, pictures and other representations. A major principle in cognitive psychology is that man organizes impressions and knowledge into meaningful units. This process starts with attention and perception. Psychological information theory describes the cognitive processes in the brain as a flow of information between different memory functions. In philosophy, *semantic information theory*

refers to the information supplied by a proposition in terms of the proposition's probability, and specifies the principles for measuring of such information.

Social information, i.e., the result of all information measures whose aim is to make it easier for citizens to know what their rights, privileges, and obligations are, is studied in social science subjects. Good social information should be readily accessible, tailored to local requirements, readily grasped, adapted to individual needs, and capable of creating a state of preparedness in the receiver. Social information must be closely integrated with the activities of the respective authorities, professionally planned and designed, and disseminated through efficient media.

1.2 Design disciplines

The term *design* is related to the latin word *designare*, to mark out, define; *de-*, out, from + *signare*, to mark (Little 1965). In *The Concise English Dictionary* (Hayward & Sparkes 1984) the word *design* is defined (p. 303) as:

v.t. To contrive, to formulate, to project; to draw, to plan, to sketch out; to purpose, to intend; to appropriate, to devote or apply to a particular purpose; to point out, to specify, to appoint. *v.i.* To draw, esp. decorative figures. *n.* A plan, a scheme; a purpose, an object, an intention; thought and intention as revealed in the correlation of parts or adaptation of means to an end; an arrangement of forms and colours intended to be executed in durable material; a preliminary sketch, a study; a working plan; the art of designing; artistic structure, proportion, balance etc.; plot, construction, general idea; artistic invention.

(Here *v.t.* means verb transitive, *v.i.* verb intransitive, and *n.* noun.) In the *The new Shorter Oxford English Dictionary on Historical Principles* (Brown 1993) the general meaning of the word *design* is defined (p. 645) as:

... plan and execute (a structure, work of art, etc.); fashion, shape; make a preliminary sketch for (a work of art, etc.); make drawings and plans for the construction of production of (a building, machine, garment, etc.).

In *The New Websters Dictionary and Thesaurus* (Ottenheimer 1991) the word *design* is defined (p. 110) as:

v.t. draw the outline of; to plan; *v.i.* to purpose; *n.* sketch in outline (esp. in architecture): a pattern (as in wallpaper, printed cloth, etc.); scheme or plan; purpose.

Lauer (1990:2) defined design as:

... the planned arrangement of elements to form a visual pattern. Depending on the field, these elements will vary – all the way from painted symbols to written words to windows or furniture. But the result in each case is always a *visual* orga-

nization. To *design* means to *plan*, to *organize*. Design is essentially the opposite of chance.

In connection with a discussion on “instructional message design” Fleming and Levie (1993:x) noted that the term *design*:

refers to a deliberate process of analysis and synthesis that begins with an instructional problem and concludes with a concrete plan or blueprint for a solution.

On its homepage the *International Institute for Information Design* (IIID 1997) defines the word *design*:

Design is the identifying of a problem and the intellectual creative effort of an originator, manifesting itself in drawings or plans which include schemes and specifications.

The IIID definition may probably be used for most kinds of design, where the coordination of eye, hand, and brain is essential to the way the painter, sculptor, architect, and designer creates. According to Smith and Ragan (1999:4) the term design implies a systematic or intensive planning and ideation process prior to the development of something or the execution of some plan in order to solve a specific problem. Fundamentally, design is a type of problem solving and it has much in common with problem solving in other kinds of professions. However, Mijkse-naar (1997: 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.

Based on the above definitions and on practical design activities we may distinguish between several *design concepts* such as (1) design processes, (2) design activities, (3) design areas, (4) design levels, (5) design perspectives, and (6) final designs. A *design process* includes the development from a concept or an idea to a final product. Steps in the design process may be called *design activities*, such as conceptual design, embodiment design, detail design, and design reviews. Thus the design process includes cognitive as well as practical aspects and activities.

Shadrin (1992:29) discussed the area of problem solving based on the following seven design process steps or “constants” as a 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?)

The design process includes cognitive as well as practical aspects and activities. Rowland (1993) has studied the process of design across a number of professions. According to him main principles of design include the following characteristics:

- Designing requires a balance of reason and intuition, an impetus to act, and an ability to reflect on actions taken.
- The design process is a learning process.
- Designing is a goal-directed process in which the goal is to conceive and realize some new thing.
- 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.
- Design requires social interaction.
- Designing involves problem solving, but not all problem solving is designing.
- In designing, problem understanding and problem solving may be simultaneous or sequential processes.
- Designing involves technical skills and creativity and rational and intuitive thought processes.

The concept *design areas* include many areas, or parts of areas such as: apparel design, architectural design, audio design, ceramics design, communication design, costume design, craft design, document design, editorial design, engineering design, environmental design, exhibition design, fashion design, fine arts design, furniture design, glass design, graphic design, image design, industrial design, information design, instruction design, instructional message design, interaction design, interface design, interior design, IT design, landscape design, light design, manufacturing design, mechanical design, message design, molecular design, ornamental design, package design, pattern design, persuasion design, poster design, product design, retail design, service design, text design, textile design, type design, urban design, and web design.

Some of these design areas partly overlap other disciplines, and there are probably even more design areas. Some design areas are old and some rather new. According to Head (2000) the concept of *design language* describes how interfaces communicate what objects are to users, what they might do, and how they should be used. The concept *design levels* includes areas such as: design of projects, design of processes, design of tools, design of products, and design of systems. *Design perspectives* include views such as: theory, craft, manufacturing, technology, and users. The *design discourse* includes all the design literature and research reports dealing with design matters.

The (final) *design* represents the outcomes of each specific design process, such as products, services, processes, and systems. On a theoretical level the intention

of the overall design process might be the same regardless of the specific design area. Today's design motto is very much: "function can take any form". According to Mijksenaar (1997: 15) this phrase is an adaptation of the famous: "form follows function" which can be traced back to the american sculptor Horatio Greenough, who had used it in *Form and Function*, written in 1851.

A group of design disciplines all deal with the design of messages. This "design family" may be called "message design". Message design is an interdisciplinary field of knowledge. It encompasses influences and facts from more than fifty established disciplines and areas of research. The main areas of research may be divided into the following six groups with "base disciplines". However, also other groupings are possible.

1. **Language disciplines** such as drama, graphic design, linguistics, rhetoric, semiology/semiotics, verbal languages, visual languages and visual literacy. (From a message design perspective the language aspects of graphic design are more important than the art aspects.)
2. **Art and aesthetic disciplines** such as aesthetics, computer graphics, film and cinema, iconography, iconology, illustration, and photography.
3. **Information disciplines** such as computer science, information processing, and library and information science.
4. **Communication disciplines** such as communication theory, education technology, information design, information technology, information theory, instructional design, instructional message design, instructional technology, journalism, media studies, persuasive design, planned communication, television and video.
5. **Behavioural and cognitive disciplines** such as cognitive science, didactics, information ergonomics, pedagogy, psychology, sociology and their subareas. The study of attention, perception, cognitive skills and memory are especially important. Some aspects deal with individuals, and some with the societies in which we live.
6. **Business and media production technology disciplines** such as business economics and management, information economics, information management, law, technologies for production and distribution of different media.

The "message design model" (Figure 1.1) was formerly called the "basic information design model" (Pettersson 1998a, 1998b, 1998c). It is a theoretical model showing that different disciplines *influence and contribute* to the area of message design. Please note that the ovals representing the various groups of disciplines are not meant to be sharp and distinct. The borders between these groups are rather blurred, unclear, and indistinct. Furthermore, the model is not intended to show any *exact* relationships between the different groups of the base disciplines.

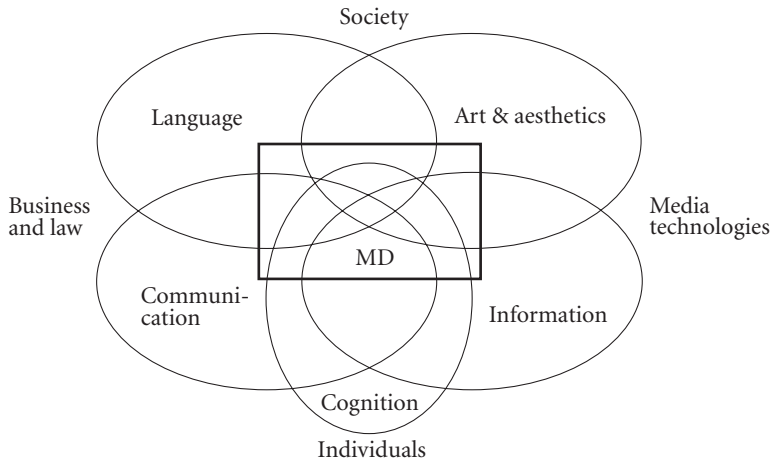


Figure 1.1 The message design model. Message design is interdisciplinary and encompasses influences and facts from more than fifty established areas of research. In this theoretical model, main areas in message design (represented by a rectangle, MD) are language disciplines, art and aesthetics disciplines, information disciplines, communication disciplines, behaviour and cognition disciplines, business and law, and media production technologies.

The main components in message design are words, visuals and form. These components may be used in many different ways to produce, transmit and interpret messages of various kinds in different communication situations. Depending on the different objectives with the messages we can see different “message design groups”, all are used for communication purposes. These groups are graphic design, mass design, persuasion design, instruction design and information design. These groups are briefly presented on the following pages.

People have been designing, planning and executing information sets, information materials, and messages in all times. The Egyptians were the first culture to produce illustrated manuscripts and wall decorations that combined their writing system with illustrations. Mullet and Sano (1995:9) 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. Although we may not think about it, the practice of graphic design is as old as recorded history, and we see the results of graphic design every day. We see books, magazines, packages, papers, posters, symbols, and many other products.

Graphic design is a kind of “all-purpose design”. In graphic design the main objective is to provide functional, aesthetic, and organised structure to all kinds of information sets. Here, the information interpreter might be seen as a “reader”. Graphic design is used as an important “tool” in the other four groups of message design: mass design, persuasion design, instruction design, and information design. Today graphic design is a natural part of these design areas and many graphic designers work in these areas.

I use the term *mass design* as an umbrella term in order to bring related mass design areas together. This message design group could also be labelled “entertainment design”. Mass design includes aspects from communication studies, mass-communication, media studies, photography, and journalism. Thus it is a very large field. Here the main intentions with the “messages” are to provide news, views, and entertainment to large audiences. The individual information interpreter might be seen as a “relaxer”.

1.2.1 Persuasion design

Advertising is not a new activity or a new invention. Crude ads appeared as inscriptions in Egyptian tombs already around 3,000 BC. Later the Greeks engraved theatre ads in stone in about 500 BC. Signs of different kinds were hand painted on the lime-whitened walls of buildings in Rome and Pompeii. However, advertising came of age in the twentieth century. Saunders (1999:7) argued that the advertising of today is the world’s most powerful industry. Advertising is more powerful now than it has previously been at any time in history. An advertising campaign can change the public opinion. It can make a company’s fortune, and it can put politicians in power.

I use the term *persuasion design* as an umbrella term in order to bring related persuasive areas together. This group includes main aspects from *planned communication*, *persuasive communication*, *advertising*, and *propaganda*. Persuasion design comprises studies on carefully planned information activities, where the goals are related to some kind of change in the behaviour of the receivers. Receivers are typically asked to *do something*. Ads may ask people to vote, go to church or stop smoking, and often the intention is to persuade them to buy a specific service or product. While advertising presents positive images, propaganda often creates negative images. Propaganda reinforces our prejudices and feelings regarding events, people, and products.

Bettinghaus and Cody (1987:1) noted that *persuasion* is an important part of the daily life of every human being. What we eat, what we wear, whom we listen to, what music we prefer, what church we go to, and whom we will vote for in the next election are all affected by persuasive communication. In fact, persuasion is used

so frequently and is so pervasive in our daily lives that we often fail to recognize when we are using persuasive communication, as well as when we are exposed to it. Moriarty (1991:5) sees an *advertisement* as a conversation with a customer about a product.

It gets attention, it provides information, it tries to make a point, and it encourages you to buy, try, or do something. It tries to create some kind of response or reaction. It speaks to the heart as well as the head.

Advertising is also a form of mass-communication, which is much more complex than a regular conversation.

People in the advertising business tend to think about the *advertising process* as a traditional communication model. The advertising process involves a source or a sender (the advertiser), encoding (the professional in advertising), a representation with a message (the advertisement) and one or more channels (the selected media), noise (various obstacles), receivers (listeners, readers, viewers), decoding of the message (understanding), and feedback (the viewer's responses). The *elements* of an advertising *message* are the words, the pictures, the music, the sounds, the characters, the setting, 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, senders must exchange information, accurately transmit their messages and intentions, and identify and understand the habits of the intended receivers.

As a result of successful persuasion design the selected receivers, or interpreters, will get new views, opinions, emotions, reinforced attitudes, beliefs, a willingness to buy, apprehensions or prejudices. As a minimal condition, to be labelled as persuasive, a communication situation must involve a conscious attempt by one individual to change the attitudes, beliefs, or behaviour of another individual or group of individuals through the transmission of some message (Bettinghaus & Cody 1987:3). Persuasion designers work with all kinds of verbo-visual representations (lexi-visual, audio-visual, and multi-visual) and with all media.

1.2.2 Instruction design

I use the term *instruction design* (Pettersson 1998a) as an umbrella term in order to bring related instruction areas together. The message design group instruction design includes audio-visual instruction, educational technology, instructional technology, instructional design, and instructional message design. Instruction design is interdisciplinary and includes main aspects from several areas dealing with instruction and learning, but from different perspectives, and with different emphasis. Within each area the various definitions and descriptions have changed over time, which is sometimes confusing.

1.2.2.1 *Audiovisual instruction*

Today the term “audiovisual instruction” is more or less obsolete, and not often used. It is only mentioned here for historical and evolutionary reasons. According to De Vaney and Butler (1997:6) the objects of study, the basic concepts of audiovisual instruction, and the notion of audience had been circumscribed already in the period between 1918 and 1941. During this period the area of audiovisual instruction for students was promoted by interested educators, librarians, school administrators, film makers, radio programme designers, textbook producers, and other media enthusiasts. World War II research on instruction, training and learning indicated that films were good at teaching facts, and adequate at developing attitudes. The texts of the late 1920s and early 1930s were mainly concerned with operation of machines in public school classrooms. The audiovisual scholars of the 1920s and most of the 1930s followed prevalent theoretical and methodological trends in educational psychology. We might say that audiovisual instruction has evolved into educational technology and further into instructional technology.

1.2.2.2 *Educational technology*

For many people the term *educational technology* is just another name for instructional media or audiovisual aids. However, it is not. Only a small portion of educational technology is concerned with audiovisual aids. It is the word technology that causes problems here, because it has different meanings. Technology includes the systematic study of *technique* as well as the *application of science* to the solution of practical problems. *Educational technology is concerned with making instruction more effective and more efficient.* Members of this profession recognize that while educational technology is a dynamic emerging area, it is still seeking a definition. The various definitions and descriptions have changed over time, and people within this area have not yet reached an agreement.

In their overview, *Voices of the Founders: Early Discourses in Educational Technology*, De Vaney and Butler (1997:3) concluded that while academic audiovisual and educational technology programmes started in the 1950s and proliferated in the 1960s, the intellectual groundwork for this area emerged already in the late 1920s and peaked in the 1940s with the capstone event of programmatic and extensive World War II research. Morgan (1978:143) dated “the origin of educational technology from the work of B. F. Skinner and others on programmed instruction”. Skinner’s research into operant conditioning and animal learning led him to suggest that human learning could be maximized by the careful control of reinforcement for desired behaviours (Skinner 1953).

Saettler (1968, 1990) wrote a detailed history of educational and instructional technology and noted the emergence of the role of the *instructional technologist*. During the process of creating military training films, this specific role emerged as

distinct from that of the *subject matter expert* and the *technical expert* in film making. The need for a professional who could contribute expertise in education to the knowledge of the subject matter expert and the technical expertise of producers was clear to the military staff. The basic *instructional team*, with (1) designer, (2) subject matter expert, and (3) producer working together, was conceived during World War II.

1.2.2.3 *Instructional technology*

With roots in the use of audiovisual media and audiovisual instruction during World War II in training and teaching, and research on educational technology, the term *instructional technology* was introduced in the 1960s. According to Dijkstra, van Hout Wolters, and van der Sijde (1990) the term *instructional technology* was introduced in order to give a description of methods and procedures of instruction used to promote the acquisition of knowledge and cognitive skills, mainly in classrooms and other formal learning situations. *The Commission on Instructional Technology* (1970: 19) defined instructional technology in two ways:

1. as “the media born of the communications revolution which can be used for instructional purposes alongside the teacher, textbook, and blackboard”;
2. as “a systematic way of designing, carrying out, and evaluating the total process of learning and teaching in terms of specific objectives, based on research in human learning and communication, and employing a combination of human and non-human resources to bring about more effective instruction”.

It was concluded that the purpose of instructional technology is to make education more productive and more individual, to give instruction a more scientific base, and to make instruction more powerful, learning more immediate, and access more equal. In 1994 the Association for Educational Communications and Technology (AECT) published Seels and Richey’s *Instructional technology: The definition and domains of the field*. The 1994 definition (p. 1) is:

Instructional Technology is the theory and practice of design, development, utilization, management, and evaluation of processes and resources for learning.

This definition describes the field in terms of five domains. It may be concluded that instructional technology can be viewed as a subset of educational technology. However, it can also be seen as an outgrowth and evolution from educational technology.

1.2.2.4 *Instructional design*

In 1974 Gagné and Briggs introduced the term *instructional design*. They showed the influence of cognitive psychology on the description of different types of learn-

ing, and on the analysis of the learning task. Glaser (1978) showed that the study of acquisition of complex human behaviours in formal instructional settings will contribute both (1) to the theory of knowledge acquisition within the science of cognition, and (2) to the *technology of instruction*. In 1982 Heinich, Molenda, and Russell defined the term *instruction* as (p. 9):

Deliberate arrangement of experience(s) to help a learner achieve a desirable change in performance; the management of learning, which in education and training is primarily the function of the instructor.

Later (p. 19) they defined *technology of instruction* as:

... the application of our scientific knowledge about human learning to the practical tasks of teaching and learning.

Briggs and Wager (1989) published a handbook of the procedures for the design of instruction. Here the central focus is on the *design of instructional materials*, whether print or non-print. The book is mainly written for the instructors who want to learn how to (p. v):

... develop predesigned, *materials-centered* instruction, as distinct from *teacher-centered* instruction.

Today, however, it may be time to focus on *learner-centred* instruction rather than materials- or teacher-centred instruction. In 1993 Wileman defined instructional design as (p. 112): “the process of planning lessons based on learning objectives”.

Reigeluth (1983, 1987) defined three types of main variables in instructional design. These variables are (1) methods, (2) outcomes, and (3) conditions. When a designer is to solve an instructional problem, he or she will use the available knowledge about the system and the conditions at hand, and vary the method variables in such a way and toward such values that the desired outcome is achieved.

1.2.2.5 *Instructional message design*

Fleming and Levie (1978) specified that the term *instructional message design* refers to the process of manipulating, or planning for the manipulation of, a pattern of signs and symbols that may provide the conditions for learning. It is assumed that practitioners in this domain can be more effective if they make use of appropriate generalized research findings from the behavioural sciences. Here the term *instruction* refers as well to classroom contexts as to more informal contexts where attitudes, concepts, and skills are communicated. In the *The new Shorter Oxford English Dictionary on Historical Principles* (Brown 1993) the term *message* is defined (p. 1752) as:

... brief communication transmitted through a messenger or other agency; an oral, written, or recorded communication sent from one person or a group to another.

Please note, that it is implied here that the message actually is *received* by the interpreters. The influence of cognitive psychology on instructional message design was further developed by Gagné, Briggs and Wager (1988), and by (Dijkstra et al. 1990). According to Fleming and Levie (1993:x):

A 'message' is a pattern of signs (words, pictures, gestures) produced for the purpose of modifying the psychomotor, cognitive, or affective behaviour of one or more persons. The term does not imply any particular medium or vehicle of instruction.

In principle the term is valid for all media. Instructional message design theories provide principles for the design of instruction. In a few cases they intend also to provide teachers with prescriptions. During the last two decades design models and theories of instruction have become important for the work of professional instructional designers. Although design theories frequently refer to descriptive theory and propositions, their main function is to guide the designers on how to design and how to produce courses and lessons.

We can note a paradigm shift from the old and traditional focus on teaching to a focus on learning. In summary, the main function of *audiovisual instruction*, *educational technology*, *instructional technology*, *instructional design*, *technology of instruction*, and *instructional message design* is to guide the professional designers on how to design and how to produce courses, lessons and materials *intended for learning*. There seems to be no major difference between these areas, and they are all closely related to *information design*.

1.2.3 Information design

Information studies, media and communication studies, as well as design studies are broad areas of knowledge with connections to several other areas. Many studies have mainly dealt with various aspects of verbal information in different media. Quite often the pictures and images in the messages have been overlooked and forgotten.

Already in the 1950s and 1960s Lidman and Lund (1972) described the advantages with an *informative layout* where words, pictures and graphic design work together to form a message that is easy for the reader to receive and understand. They called this the *third language* as well as *lexi-visual layout*. In contrast to the traditional *artistic layout*, which may please the individual artistic graphic designer, but which has no relation to the content of the message. An informative layout has a *practical purpose*. The lexi-visual narrators were encouraged by Lidman and Lund to consider three important aspects: (1) the theme of the content, (2) the pedagogical purpose, and (3) the aesthetic form. Lexi-visual products are the result of

teamwork between subject matter experts, visualizers and editors. The lexi-visual layout was used in the production of visualized encyclopedias for a general market.

Tufte (1990) noted that the term *information design* (ID) has often been used for aesthetic graphic design of information materials. However, Easterby and Zwaga (1984) had provided a wider 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 different standpoints – aesthetic, empirical, evaluative, quantitative, pragmatic, practical – and also to differing degrees, depending on the relative importance that these aspects have in relation to their professional interests and obligations.

In 1979 the *Information Design Journal* (IDJ) started. According to Waller (IDA 1997) IDJ was intended to be a counterpoint to the corporate identity and glitzy graphics that seemed to take over graphic design in the 1980s. From the beginning IDJ used a distinctive meaning for the term *information design*:

... to apply processes of design (that is, planning) to the communication of information (its content and language as well as its form).

With reference to the display of quantitative information Tufte (1983:87) 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.

It should be noted that this statement was made in 1983. Today, the situation may be different. Mok (1996) argued that (p. 46):

Everybody already knows what information design is, whether they realize it or not.

However, later in the book Mok provided a definition of information design (p. 108):

Information design is the arrangement of organization models to provide context and meaning for the information.

A search on the the Web (in January 2002) for the term information design gave more than 6,500 hits. These hits indicated that the term was used for a wider concept than graphic design of information materials. The focus seemed to be on functional verbo-visual communication rather than on aesthetics alone. In the age of information we have an ever increasing need for computer-based learning, computer interfaces, directories, educational materials, exhibitions, forms, graphic symbols, hypertext systems and multimedia products, instructional materials, learning materials, lists, maintenance information, manuals, non-fiction books, on-line help for managing computer-based systems, procedural aids, product descriptions; public information systems in hospitals, museums and transport systems; reference books, road traffic signs, system descriptions, tables, technical reports, tickets, webpages, and other kinds of information materials. These are examples of *information utility goods* that we need to perform our tasks at work. We also need an increasing amount of information materials during our leisure time, in order to be able to handle things like new cameras, cars, CD-players, computers, computer software, etc. *A well designed information material makes everyday life easier for people, and it grants good credibility to the senders or sources.* However, in the future we will focus more on the actual *information content* rather than on the traditional *information materials* as such. We may need access to the information required for maintenance of a machine, not necessarily for a printed document with this information. Thus many traditional printed documents will be replaced by on-line services. This is a paradigm shift.

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 rewriting and editing 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 here the focus is on *workability*. Wileman (1993:6) 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.

A well designed information product will satisfy aesthetic, economic, ergonomic, as well as subject matter requirements. Mullet and Sano (1995:2) 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 as well as message design tools. On its homepage the *International Institute for Information Design* (IIID) defines information design in the following way (1997):

Information design is the defining, planning, and shaping of the contents of a message and the environments it is presented in with the intention of achieving particular objectives in relation to the needs of users. At this point of the development IIID is concerned with the design of visual information but it could in the future include the design of information other than visual one.

These two definitions were recommended by the 2nd IIID Conference in 1994. They have also been published in several issues of the *ID News*. The main concern of the IIID is to contribute to a better understanding within the human community with respect to cultural and economic issues by means of improved visual communication. IIID is supported by UNESCO (1995), and endeavours to develop information design as an independent interdisciplinary field of knowledge and professional activities. Horn (1999) defined information design in this way (p. 15–16):

Information design is defined as the art and science of preparing information so that it can be used by human beings with efficiency and effectiveness. Its primary objectives are:

1. To develop documents that are comprehensible, rapidly and accurately retrievable, and easy to translate into effective action.
2. To design interactions with equipment that are easy, natural, and as pleasant as possible. This involves solving many problems in the design of the human-computer interface.
3. To enable people to find their way in three-dimensional space with comfort and ease – especially urban space, but also, given recent developments, virtual space.

The values that distinguish information design from other kinds of design are efficiency and effectiveness at accomplishing the communicative purpose.

As previously noted information design can be hard to define and describe, and often goes by other names. In my view (Pettersson 1998) information design may be described in the following way:

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 set will satisfy aesthetic, economic, ergonomic, as well as subject matter requirements.

Information design of today (Figure 1.2) has its origin and its roots (1) in *graphic design* (informative layout, lexi-visual layout, the third language, visual presentation, information design, and communication design), (2) in *education* and teaching, or rather *instruction* (audiovisual instruction, educational technology, instructional technology, instructional design, instructional message design, and visual literacy), and (3) in architecture and engineering, or rather *construction and production* (technical illustration, technical writing, visual presentation, information design, and technical communication). In these areas people have recognized the need for clear and distinct presentation and interpretation of verbo-visual information.

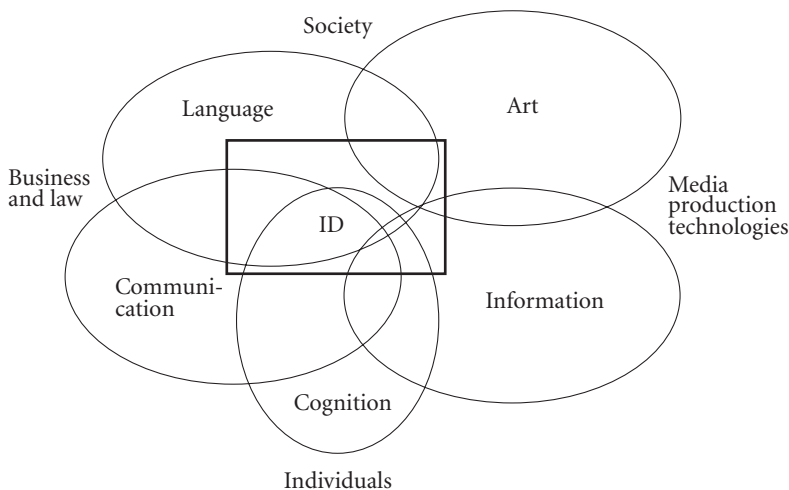


Figure 1.2 The information design model. The areas representing the groups of base disciplines have been moved relative to the information design rectangle in order to better represent the evaluated importance for information design of each group of base disciplines. Thus language disciplines are more important to information design than art, etc.

The study of information design can be summarised as a multi-disciplinary, multi-dimensional and worldwide consideration. We can view and describe information design from various perspectives, or research angles. In my view the six most prominent perspectives are: (1) areas of knowledge, (2) areas of design, (3) types of content, (4) types of representation, (5) parts of communication, and (6) message contexts.

From a cognitive point of view, information design is less demanding than instruction design. In instruction design the receiver is to (usually) *learn* from the message. However, in communication design and information design the receiver only has to be able to *understand* the message in order to use the information in a practical situation. In many situations this will, of course, also result in learning. But learning is usually not required. Like architecture, dance, fine arts, music and theatre, also information design has a practical as well as a theoretical component. Like the two faces of a coin, *infography* and *infology* are the two main parts of information design. As a discipline and an academic subject matter information design has three main areas of knowledge: infography, infology, and infodidactics.

Infography is the actual, practical formation and execution of structured combinations of text, pictures, and graphic design (Pettersson 1989, 1993). The term was initially used mainly for information graphics in newspapers and television, but has more recently been used in a wider perspective for formation and execution of all kinds of verbo-visual messages used for the presentation of information in all media. Information design practitioners seek to make complex information easier to understand for the intended receivers. The goal is to achieve excellent design skills. An *information designer* (or infographer) needs to have 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 (Pettersson 1997). The legibility of a graphical message is determined by the design of its text and pictures, as well as by their clarity. Usually a team of people with skills in the different areas are working together. The task is usually too overwhelming for a single person.

Art is valued for its originality and expressiveness. Its focus is on individual artifacts crafted through the manual and aesthetic virtuosity of the artist. Design, in contrast, is valued for its fitness to a particular user and to a particular task (Mullet & Sano 1995:8). Of course many designers may want to provide one or more 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.

Infology is the science of verbo-visual presentation and interpretation of information. On the basis of man's prerequisites, infology encompasses studies of the way a verbo-visual representation should be designed in order to achieve opti-

imum communication between sender and receiver (Pettersson 1989, 1993). Infology models contain both theoretical (de-scriptive) elements as well as normative (prescriptive) elements. Producers of information and learning materials can facilitate communication, and the learning processes of the readers. Complicated language, in both texts and pictures, will impair the understanding of the message. Active voice, clarity, comprehensibility, consistency, legibility, precision, readability, reading value, simplicity, and structure are the key concepts in information design. Any graphical message should be legible, readable, and well worth reading for the intended audience. Any audial message should be audible, distinct, and well worth listening to for the intended audience. The main goal in information and instruction design should always be *clarity of communication*. The presentations might also be exciting, aesthetically pleasing and visually rewarding.

Infodidactics is the methods used for teaching the various aspects of information design. The huge spread among the different disciplines makes information design an interesting, but also a complex area of research and teaching. The goal of all scientific enterprise is *understanding*. When we understand a subject matter we are able to explain phenomena and predict new phenomena. Although information design theories frequently refer to descriptive theory and propositions, their main function is to guide the information designers in how to actually design, present and produce information materials. In order to do this, it is important to work with problem-oriented learning in realistic projects; with existing and true problems, with regular senders, with actual information materials, and with real receivers that need the information. This also provides realistic experience with budget and time limits.

Information design encompasses studies of the way a representation should be designed in order to achieve optimum communication between the sender and the receiver. Thus, some studies are concentrated on the communication processes as such, some on the sender, some on the representation, and some on the receiver. A verbo-visual representation can be designed in different ways. Based on how the verbal information is presented to the receivers, we can distinguish three main types of verbo-visual representations (Pettersson 1989, 1993). We read the printed words in lexi-visual representations, such as messages printed in a book or messages displayed on a computer screen. We listen to the spoken words in audio-visual representations, such as oral presentations with slides or overhead transparencies and in television programmes. We read printed words and listen to spoken words in a combination of lexi-visual and audio-visual representations in multi-visual representations, such as interactive multimedia systems.

A *context perspective* on information design includes the inner context, the close context, and the social context. Factors inside the medium provide the inner context. The inner context is an internal context. In a book it is the relationship

between various text elements, pictures and layout. We may also discuss the relationships between the image elements within a single picture. The entire communications situation, i.e., senders and their intentions for the verbo-visual message, and receivers and their circumstances provide the social context. When we read a book or view projected images the lighting in the room may exemplify the close context. The close context and the social context are both external contexts. The context has a major impact on the way that a message is perceived.

1.3 Communication

In the industrialized, cultural sphere, we are today living in mass-media or information societies. 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 simple signals. The signals may be aural or visual. They can also consist of odours or tactile contacts and act on our sense of smell and touch rather than on our hearing and vision. There is often an interplay between different signals or stimuli which coalesce into a unified whole.

1.3.1 Communication models

The traditional view is that communication takes place when a sender conveys one or more messages to one or more receivers. The sender successfully transfers a message to the receivers with the help of different media. It is indicated here that the sender is the active part, and the receiver is a more or less passive part. Here a medium and its contents (the message) constitute a “representation” (Figure 1.3).

We can be sure that people do not derive the same information from things they read, hear, or see. The meaning of any language, verbal or visual, is resident not only in words, lines, shapes and colours, but in ourselves to a large degree. We have to learn to assign meaning to language symbols used. We have to learn the codes, and they differ in different societies and in different cultures. Sometimes a representation is called an “information set”, an “information material”, or a “learning material”. In this book the emphasis is on the design of information and learning materials.

In the production of information and materials for learning, a sender conveys information on a part of reality via a representation to an information receiver who, via sensory impressions, is able to obtain a perception of that specific part of reality. This perception may then evoke responses that affect reality and create feedback to the original sender. In this case the receiver becomes a sender, and the

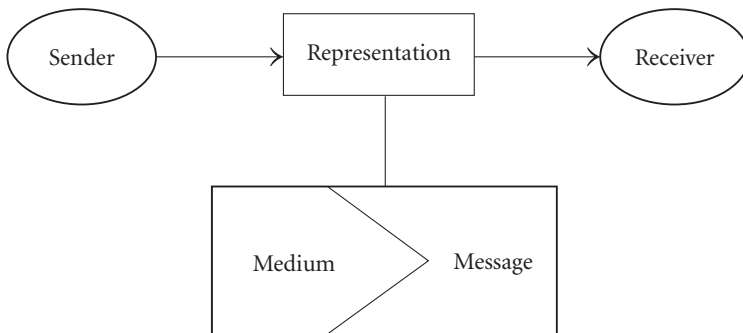
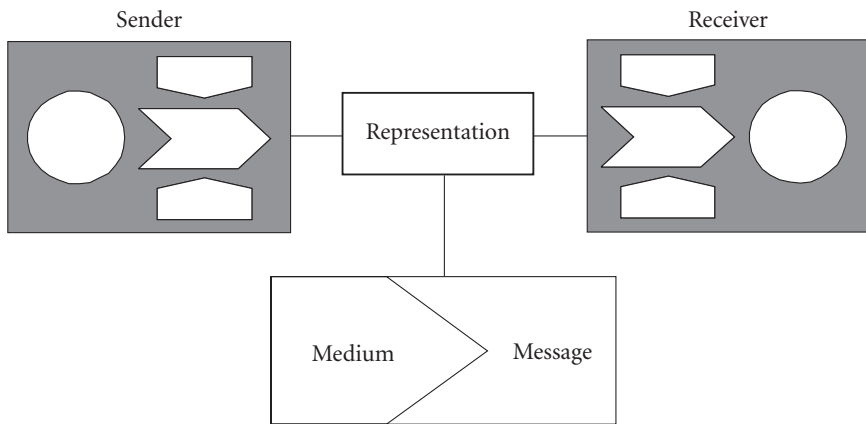


Figure 1.3 A communication model. A “representation” is a medium with a specific message. The (active) sender transfers a message to the (passive) receiver with the help of a medium.



Social context

Figure 1.4 Active communication. Several activities are involved when an intended message (left circle) is communicated from a sender to a receiver, and received as an internalized message (right circle). These processes (process arrows) are guided by principles (upper pentagons), performed with the help of tools (lower pentagons) and influenced by the social context. In this model the receiver, or “interpreter”, may actively reach out and grab the representation with its message.

sender becomes a receiver. Actually, both the sender and the receiver are involved in several activities when a message is communicated.

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 evoke feedback

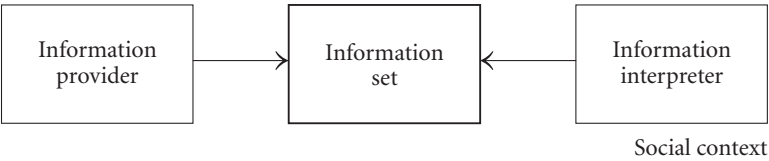


Figure 1.5 An information set model. An information provider makes one or more information sets available for people who need the information, information interpreters. In this model the focus is on the *information set*, rather than on the information provider or the information interpreters.

to the original sender, the receiver becomes a sender, and the sender becomes a receiver. These processes are performed with the help of tools and influenced by the social context. This expanded communications model (Figure 1.4) better show the different activities involved when an intended message is produced, communicated, received and processed to an internalized message. In this model of active communication, and in the following chapters, the main emphasis is on the sender, and on the production and presentation of information and learning materials. However, the focus is on the receiver in the final chapter of this book.

Traditional communication models are directional and process-oriented. However, Hall (1980) developed the encoding – decoding model. Here the sender is 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 the intended meaning of the message. Hall emphasised the paradigm shift to earlier traditions. During the 1990s there has been 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). We can see the sender as an “information provider” (Pettersson 1999). In each case the sender or the designer may have clear intentions and objectives. However, it is up to the individual “information interpreter” to actively conceive or misconceive the information, to use or not use it, to use or misuse it. This view (Figure 1.5) is specially valid for information sets that people make available to an unknown audience, e.g. on the Internet and the the Web. Here it is usually not possible to know much about the people who search for, and use the information.

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.

1.3.2 Message objectives

Several researchers have pointed out that it is important to define clear objectives in message design (Heinich et al. 1982; Marsh 1983; Fleming & Levie 1993; Wileman 1993; Mullet & Sano 1995, and Pettersson 1998). A performance, and a change in behaviour, must be observable. Thus subjective objectives defined by verbs like appreciate, assess, describe, discuss, evaluate, know, outline, and understand should be avoided. A statement of design objectives should include the conditions under which the required performance is to be observed and measured, when such conditions are relevant. Time and accuracy are often meaningful dimensions in assessment of objectives. When performance is qualitative rather than quantitative, the performance may be assessed by a group of experts. It is possible to compare different kinds of mediated products using a *message objectives diagram* (Figure 1.6). This diagram is a rhomb, divided in four parts. Each part represents different sets of objectives and receiver activities that may be noted as a cognitive state of mood.

The first part, *learning* and subsequent knowledge is located in the top corner. Knowledge may develop into insight and wisdom. The second part is the right corner. It represents *experiencing feelings* such as beliefs, delight, desire or willingness to buy something, distress, dread, eagerness, excitement, fear, fun, grief, happiness, mourning, opinions, pleasure, prejudices, romance, satisfaction, sorrow, and tension. The third part at the bottom corner represents *relaxation*, such as ease, rest, and slackening. The fourth part at the left corner represents *understanding*, including awareness, consciousness, and understanding of facts.

The message objectives diagram may be used for an easy visual presentation of similarities and differences between the materials and products that are the results of work within various design areas. It is quite obvious that the objectives for a phone book is very different from the objectives for an advertisement, a detective story, or a lawbook. There are also products with two, or even more objectives. As an example the objectives for an educational TV-program may be to create an



Figure 1.6 Examples of message objectives diagrams for different kinds of messages in materials and products. Messages in different media will look the same when the objectives are the same.

understanding, as well as learning of some facts. The objectives with entertainment in TV may be to provide relaxation and fun.

Various areas of design have different objectives and the materials and products reach out to different groups of receivers. Based on the intended purposes, the different areas related to design of information sets and information materials may be grouped into five main categories: (1) Graphic design objectives, (2) Mass design objectives, (3) Persuasion design objectives, (4) Information design objectives, and (5) Instruction design objectives.

In *graphic design* the main objective is to provide functional, aesthetic, and organised structure to all kinds of information sets. The information interpreters might be seen as “readers”. They may develop new views, relaxation, emotions, awareness, attention, and understanding. It may be an advantage to use verbs like *find*, *identify*, *read*, and *recognise*. These verbs all denote observable behaviour. A few examples of performance objectives in graphic design may be:

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

Please note that in this example, as well as in the following examples the actual numbers have to be decided in each specific case.

Mass design includes aspects from communication studies, mass-communication, media studies, and journalism. Here the main intentions are to provide news, views, and entertainment. The information interpreters might be seen as “relaxers”. They may develop views, relaxation, emotions, and awareness. In mass design it may be an advantage to use verbs like *feel*, *laugh*, *look*, *read*, and *relax*. These verbs all denote observable behaviour. A few examples of performance objectives in mass design may be:

- For a weekly magazine: 100% of the readers should be able to read and understand the text in the magazine without any difficulty.
- For news on television: 70% of the subscribers should look at the news program at least once every day.
- For entertainment on television: 80% of the viewers should have fun and laugh at the jokes in the program.

In *persuasion design* the main objective is to persuade the interpreter of the message to buy a product or a service, or to change his or her behaviour. The information interpreters might be seen as “possible buyers”, or so called “prospects”. They may develop new prejudices, apprehensions, willingness to buy, beliefs, reinforced attitudes, emotions, opinions, and views. In persuasion design it may be an advantage to use verbs like *appreciate*, *believe*, *buy*, *change* (behaviour), *desire*, *dread*, *fear*, *feel* (*relaxed*), *hate*, and *have* (*fun*) in the writing of persuasion design objectives. These verbs all denote observable behaviour. A few examples of performance objectives in persuasion design may be:

- For a warning: 90% of the viewers should change their behaviour when they have seen the information once.
- For a new product: 75% of the viewers should desire their own sample of the product when they have seen the information twice.
- In propaganda: 90% of the population should dislike a specific behaviour when they have heard the arguments against it.
- In advertising: at least 50% of the readers should actually buy at least one item of the new consumer product within two weeks after the appearance of the advertisement.
- In marketing: the market share for a particular product must increase from ten to 25% within one year as a result of the marketing efforts.

In *instruction design* the main objective is to provide courses and learning materials needed by the interpreter in order to modify behaviour with respect to learning. The information interpreters might be seen as “learners”. They may develop new understanding, experience, comprehension, knowledge, insight, and finally wisdom. It may be an advantage to use verbs like *apply*, *arrange*, *complete*, *compose*, *conduct*, *construct*, *define*, *demonstrate*, *explain*, *find*, *identify*, *illustrate*, *label*, *modify*, *name*, *predict*, *prepare*, *recognise*, *reconstruct*, *revise*, *specify*, *verify*, and *write* in the writing of instruction design objectives. These verbs all denote observable behaviour. A few examples of performance objectives may be:

- For an exercise: 100% of the students should be able to complete the exercise within 15 minutes.
- For an excursion: 100% of the students should be able to identify and name five of the most common flowers in the specific area during the actual excursion. After the excursion 60% of the students should be able to identify and name at least five more plant species collected during the excursion.
- For an experiment: 90% of the students should be able to explain the various steps in the experiment.
- For an educational video program: 90% of the students should be able to explain and illustrate the main topic in the program within 15 minutes.

- For a textbook: 90% of the users should be able to reconstruct a segment of a text within ten minutes.
- For a textbook: 90% of the users should be able to explain four ideas presented in the text.

In *information design* the main objective is to provide information materials needed by the interpreter in order to perform specific tasks. The information interpreters might be seen as “doers”. They may develop new skills, understanding, and experience. It may be an advantage 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, recognise, reconstruct, remove, revise, sort, specify, start, type, verify*, and *write* in the writing of information design objectives. These verbs all denote observable behaviour. A few examples of performance objectives in information design may be:

- For a computer interface: 95% of the users should be able to start a new application within five minutes.
- For an exhibition: 90% of adult visitors should be able to read the texts on labels used in the exhibition without any difficulty.
- 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.

1.4 Sender activities

In the production and distribution of a verbo-visual message, the sender will use creative processes, production processes, and also distribution processes. Generally speaking, a sender may be an advertiser, an artist, a business person, 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 interpreters.

1.4.1 Organization for design of information sets

There are many different tasks and skills that may be needed in the design and production of “messages” such as information and learning materials. A number of tasks and roles, or “competence areas”, are the same for 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, one or more of sub-project leaders, subject matter experts, technical and science writers, editors, translators, information brokers, graphics editors, photographers, illustrators, fine art artists, subject matter reviewers, linguistic experts, terminology experts, pedagogues, graphic designers, and web-masters. In a *small project* it is usually not possible to employ a large number of experts. However, also in small projects we need to organize various review.

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*, an *infographer*. The *subject matter manager* may be responsible for outlining all the subject matter contents in the project, and dividing this part between the different materials. In large projects, there may be several subject matter managers involved. The *project secretary* is responsible for maintaining a continuous contact between the different sub-projects, for writing minutes from the meetings, and for the final delivery of the completed materials.

Sub-project leaders are responsible for their respective materials, and are ultimately responsible for making sure that their documents are ready on time. The sub-project leaders have continuous contact with all parties involved in the whole process. One very important aspect is copyright clearance for all materials; audio, text and visuals, brought into the design process.

Subject matter experts produce the very first synopsis with the necessary subject matter facts and information: both text and pictures. Because it is important to secure the quality the subject matter experts may also take part in the reviews of the information or learning material.

Writers, editors and communicators work on the texts and materials delivered by the subject matter experts and by the *information brokers* and they produce a finished text. This work encompasses the whole spectrum from simple editing of well written text, to completely rewriting of text to convey the intentions of the subject matter experts to the readers. If 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. This may be done by *linguistic consultants*. In certain cases, it may be necessary to get the help from skilled *translators*. *Linguistic experts* are responsible for the coordination of the lin-

guistic usage and writing style. The linguistic experts, partly, check the linguistic usage to an agreed standard, and partly, check that the writing style is consistent to an agreed standard. The linguistic experts 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 a consistent terminology.

Graphics editors work on the schematic pictures that are delivered by the subject matter experts and the 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 illustrators, fine art artists, exhibition designers, photographers, video producers, film makers, and several others to produce the other pictures and images that may be needed.

Pedagogues should review any learning material, checking that it is sufficiently legible and readable, and that it has good reading value for the intended audience. *Graphic designers* are responsible for typography and layout in the information and learning material. The graphic designers may also produce the final master for printing.

Subject matter reviewers review the subject matter contents in both text and pictures. It is very important that the data and the facts in information and learning materials are correct and also relevant to the situation. Today, 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 patentability matters.

1.4.2 Intended message

Several authors have pointed out that “form follows function”. Thus the content of a message is more important than the execution of the message. Therefore we should always begin by defining what any message is supposed to show. What is the problem that we want to solve? The information in each message will have to be structured and adapted to the needs of the specific target group, the intended readers or listeners. An intended message may consist of specific ideas, thoughts, data, information, or some subject matter facts. It is always important for the sender to make three decisions as early as possible in the information design production process:

1. Define the *purpose* of the intended message.
2. Define the *receiver/s* or the *interpreter/s* of the intended message.
3. Define the most suitable *representation* for the intended message.

The *purpose* of an intended message may be advertising of a product or a service; providing a business proposal; providing education, entertainment, information, instruction, learning, training; establishing a change of behaviour, making a decision, performing an action of any kind, or any combination of these and many other examples.

There are many groups of *receivers*. The receivers of an intended message may be business partners, colleagues, dentists, employees, course participants, ministers, students, teachers, veterinary surgeons, retired professors, teenage girls, or a “general” audience – just to mention a few groups. 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. The sender needs to consider age and gender, cultural, economical, historical, political, religious, and social factors, as well as the amount of data to be used.

Larsson (1993) provided a very “sender-oriented” view of communication. According to Larsson it is necessary for the sender to employ “a total view of all information and all communication”. Information should be related to the overall activity goals within any organization. Thus it is important for the sender to employ a wholeness perspective, continuity of operation, competence to make decisions, patience, consistency and a structured way of working. Various messages in different media should work together. In a continuous flow of information the messages will provide the receiver with an image of the organization. However, this attitude is not possible to maintain in all organisations.

It is also important for the sender to decide on the *type of representation* as early as possible. Lexi-visual, audio-visual, and multi-visual representations are subject to different message design processes. Different types of representations are partly guided by different principles, and different tools are used. However, some principles and tools are the same for different representations. For entertainment and leisure, representations close to reality might be good choices. For information and education, too much realism in the representations would make it difficult or even impossible for the viewer or learner to identify the essential learning cues. On the other hand, too little realism would also be a poor choice. A moderate amount of carefully selected realism often gives the best learning. Thus, a series of slides could be a better choice than a film in a specific learning situation. In addition, a few slides cost only a fraction of the cost of producing a film or a video program.

1.4.3 Creative processes

The sender’s creative processes are influenced by message design principles, and are performed with message design tools that are suitable for the type of representation that has been selected in each case. Message design principles can be

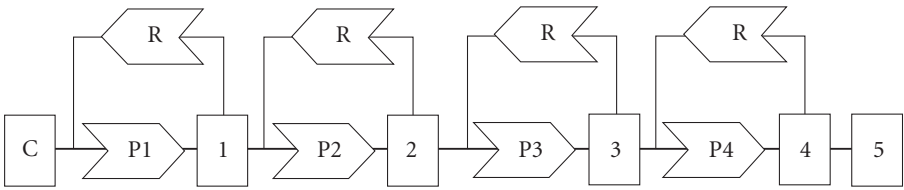


Figure 1.7 Creative processes include several different production and review activities (R). These are analysis (P1) and synopsis (1), production (P2) of draft (2), production (P3) of script (3), and production (P4) of original (4) and master (5). C = commission.

seen as guidelines for design and development of a verbo-visual message. The sender should:

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

The main creative processes for a verbo-visual message include the following four activities (Figure 1.7):

1. Analysis and synopsis.
2. Production of draft.
3. Production of script.
4. Production of original and master.

The main message design tools include text (printed and spoken), symbols, pictures (drawings and photos), typography and layout, light, and sound and sound effects.

1.4.3.1 Analysis and synopsis

During an introductory planning and analysis phase it is possible to organize the work, analyse the intended message, analyse the group of intended receivers, their specific characteristics and their requirements, get the necessary data and facts, define the purpose and the objectives, select a method for framing the verbo-visual

message, select medium, and evaluate results from tests on previous versions when there are any.

When the purpose, the objectives, 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 small team 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. 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. 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.

Adams (1999: 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 design. 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 and photographs, and also the final products. 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 video-taped for further analysis. It may be possible to provide these 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. It may also be possible to interview the test persons, or to give them questionnaires to fill in.

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 five steps:

1. *Requirements.* Analyse the commission and the requirements.
2. *Receivers.* Define the intended receivers of the information. Consider age, gender, and socio-economic factors. Consider views and any other feedback expressed by (previous) receivers.
3. *Objectives.* Define the objectives for the message.
4. *Production.* Organize the work. Select a method for framing of the verbal-visual message. Select a suitable medium. Produce synopsis for text and pictures.

5. *Reviews.* A subject matter review will ensure that the content will be relevant to the intended audience. A pedagogical review will ensure that the material will be well structured.

1.4.3.2 *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, writers, and graphics editors may produce a first draft, including 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 one project. (See Chapter 2.)
3. *Pictures.* Study the raw draft and the text. Work with image design. Draw simple sketches with explanations for drawings and photographs. (See Chapter 3.)
4. *Integration.* Organize an 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. (See Chapter 4.)
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 users may be asked to look at the drafts.

1.4.3.3 *Production of script*

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

1. *Versions.* Control the various versions of the documents.
2. *Text.* Edit the manuscript into its final version.
3. *Drawings.* Order and/or produce the originals based on previous sketches.
4. *Photographs.* Order and/or produce prints that are suitable for reproduction in accordance with previously made sketches or test shots.
5. *Graphic design.* Work with typography and layout.
6. *Copyright.* Check copyright clearance for all materials before the technical production may start. This saves a lot of trouble later on.

7. *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. Invite users to evaluate the script.

1.4.3.4 *Production of original and master*

Before any original can be confirmed as a master, where the text and the visuals finally are brought together, there should be an overall final check and review 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 before production.

The production of original and master is the final part of the creative processes for a verbo-visual message.

1.4.4 Production and distribution processes

The specified number of copies may be produced from the master. In principle, the procedure is basically the same in the production of various kinds of graphical media, in the production of AV-media, film media, video, and television programmes. In non-graphical products, *sound* and *motion* are additional assets that we may use in order to better represent the content. Quality reviews are natural as well as important parts of the different production processes.

The production processes are influenced by production principles, and are performed with production tools. The production principles can be seen as guidelines for production of any verbo-visual message. The main production principles and main production processes include production of live media, sound media, film media, broadcast media, video media, models and exhibitions, graphical media, telecommunications media, and computer media.

The production tools include pens, pencils, and other materials for manual work; computers and software to process words, texts images, and layout; printers, copying machines, and printing presses; and cameras (still, film and video). The distribution principles include economy, efficiency, and timing. The distribution processes include stock keeping of the products, marketing, advertising, selling, distribution, billing and bookkeeping. The distribution tools include stores, databases, etc.

1.5 Representations

We can distinguish between three main types of verbo-visual representations (Figure 1.8). This is based on how the verbal information is presented to the receivers.

1. We *read* the printed words in *lexi-visual representations*, such as messages printed in a book, or messages displayed on a computer screen.
2. We *listen* to the spoken words in *audio-visual representations*, such as oral presentations with slides or overhead transparencies, and in television programmes.
3. We *read* printed words and *listen* to spoken words in a combination of lexi-visual and audio-visual representations in *multi-visual representations*, such as interactive multimedia systems.

Different media can represent reality with varying facility owing to differences in the structure, in the type of representation involved, and in the contents. There are areas of general interest for all types of representations. Media considerations include areas such as costs, credibility, mass media and mass communication, media, culture and society, political situation, and technology trends. Message considerations include areas such as advertising, aesthetics, art, business presentations, education, entertainment, factual information, instruction, news, and training.



Figure 1.8 Representations. This printed picture is a representation of a photograph, which is a representation of a situation in which an artist in Paris is producing a representation (a painting) of a young girl.

Together with the medium the actual message is the link between the sender and the receiver. The sender designs the message and sends it off. The receiver receives the message, and tries to interpret and understand it. Teleman (1991) pointed out that the systems of rules that govern spoken and written languages are similar in many ways. Originally, writing was a way of depicting speech, but the two coded systems have later followed 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 dialect. 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.

1.5.1 Lexi-visual representations

In the last century, textbook visuals were often placed vertically to provide better use of page space. Sometimes an already existing illustration, for example a woodcut was used. Often, one picture was used to depict several different persons or towns. Visuals were often a kind of “paintings” with little or no real interaction with the text. In most books, pictures served primarily as an artistic supplement to the text. However, visuals have been used in a more intentional way in non-fiction books.

Information materials often consist of text. Probably no other instructional device leads to more consistently beneficial results than does adding pictures to a text. There can be no doubt that pictures combined with texts can produce strong facilitative effects on retention and learning. These effects prove to be valid for a broad range of texts, pictures, learner characteristics, and learning tasks (Levie & Lentz 1982; Levin & Lesgold 1978). Text and pictures must both be easy to read as well as complement and reinforce one another. Informative words need pictures, and informative pictures need words. It is important that we use verbal and visual representations in an optimal way.

It is not enough for a text to be well-edited, easy to understand, and interesting. The typography shall facilitate legibility. Headings, sub-headings, main text, legends, boxes and summaries must be clearly distinguished from one another. This should be accomplished in a purposeful, structured way. For example, we should not mix an excessive number of fonts, point sizes, and typefaces in the same document. Reference material, such as telephone catalogues and dictionary-

ies are examples of highly structured information. Here, a carefully thought-out, functional layout can facilitate the reader's ability to find the desired information quickly, easily, effectively, and reliably.

Both words and pictures may possess an emotive force that is not easily foreseen. A number of different value judgments may somehow slip into a text when the purpose of the text is merely to supply information. The reader's emotions may be aroused by seemingly insignificant details in a visual or nuances in the wording of a text. So sufficient effort must be invested in the editing of both texts and pictures. Interest can be focused on the central message in pictures through careful picture selection and editing, primarily by means of cropping, that is, deleting non-essential portions. Maps describe reality and shed light on a number of conditions, such as terrain, political and social subdivisions, the prevalence of certain types of soil, minerals, etc. The utilization of variations in shape and colour creates map symbols that provide a picture of the reality they represent. A carefully processed map contains more information per square inch than any other form of printed information. In that respect maps are very economical.

Information graphics provide the reader with a rapid and easily grasped overall view of a message and are therefore highly suitable as an introduction to and summary of a subject. However, conventionally illustrated text is better for analysis, discussion, and study of details. So information in graphical media can utilize text, pictures, information graphics, and graphical design in conveying its message.

Learners being exposed to "new" information may profit optimally from simple line drawings, whereas learners who are familiar with the content area may profit from more realistic types of illustrations like photographs. A wide variety of examples and non-examples enhance concept learning. In the examples the critical attributes should show as little variation and be as obvious and typical as possible. The non-critical attributes should show much variation and be as non-obvious and non-typical as possible.

1.5.2 AV and MV representations

For entertainment and leisure, representations close to reality might be good choices. For instance, it could be exciting to "walk around" among the actors in a *holographic film* in stereo sound and in realistic colour. For information and education, too much realism in the representations make it difficult or even impossible for the viewer or learner to identify the essential learning cues. On the other hand, too little realism may also be a poor choice. The information is inadequate. A moderate amount of carefully *selected realism* may give the best learning. Thus, a series of slides may be a better choice than an advanced multimedia program. In

addition, a few slides or overhead transparencies cost only a fraction of the cost of producing a film or an advanced multimedia program.

In multi-visual representations there is an interplay between lexi-visual and audio-visual presentations. Two types of presentations belong to this category: interactive systems and simulator systems. Words and visuals can be combined in different ways in each category. Systems for computer-generated visuals are being used to an increasing degree for presentations. Computer-generated visuals can be displayed with the aid of a TV projector or with an overhead projector accessory. Computer-controlled, interactive programs or databases designed for information and education can be used “interactively”.

We may not be able to attend to more than one stimulus at a 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 from the surrounding stills. It is just impossible for viewers not to be influenced by the movement in the movie. Each receiver will place available information in a wider, expanded, “personal” context. Subjects tend to feel that their particular interpretations are the correct ones. Many media can only convey limited “aspects” of the total information. Multimedia allows us to use all our senses and also to view information from different perspectives, which can improve understanding. Furthermore, the interactivity of computer based media inspire a passive observer to become an active explorer.

It is possible to create a “total information material”. This material comprises text, sound, visuals, numerical information, and facilities for processing the information in different ways. A total information material is a “multi-representational database” offering the user complete freedom in shifting back and forth between verbal, numeric, visual, and audio information. A computer program sometimes controls film projectors, VCR’s, video disc players, or other technical equipment. This then becomes a multimedia presentation worthy of the name.

Total information material offers people with all kinds of modalities, i.e., verbal, visual, kinesthetic, or mixed, to perform their own active searches for information that, when found, can be actively transformed into experience and knowledge. For example, students can easily access the background information needed for a school assignment or paper. They can even retrieve and “cut out” appropriate examples, such as “extracts” from individual databases, and “paste” and incorporate them into their own presentations. The text and picture extracts can then be edited. Numerical information in tables can be processed and presented as bar diagrams, curves, or pie charts supplying a better overview of the data. The data becomes information.

A good movie always 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 meaningless and boring to the audience. Clarity is one of the most important principles of film making. The screen-writer must have a clear-cut idea of what the story is about, otherwise the resulting movie will be confusing. A clear presentation of the subject matter is just as important in a multimedia system as in a movie. Even though many multimedia systems are not centred around a dramatic story line, there is a need to state the purpose of the system clearly and to make it clear which information the user can expect to find, where it can be found, and how it can be found. The greater freedom of a multimedia system makes it even more important that every part of the system brings the user forward towards the goal: finding the information she or he wants (Wahlman & Kindborg 1981).

In a *redundant relationship*, similar information is conveyed via words, sounds, and visuals. For example, sub-titles can be added to a television programme, so that the action displayed on the screen is described by words. This greatly enhances the educational impact of the programme. A redundant relationship should be used in instructional message design. The justification for using redundant information in print or oral (or both) and visual channels is to provide the learner with the opportunity to receive information alternatively from either channel, and to help the person short-circuit any dependence on printed or oral instruction (or both). Properly used educational technology and information design can drastically reduce the time it takes to create meaningful knowledge out of data and information.

In a *relevant relationship*, the information presented via a text or sound supplements the information supplied in the visual material. Pictures and images with relevant relationships to a spoken or to a printed text can greatly enhance the text's informative effect, and vice versa.

In an *irrelevant relationship*, the pieces of information presented in various channels are completely independent of one another. In television programmes, for example, the picture sometimes deals with one aspect, the text with another, and the sound with a third aspect. This makes it hard for viewers to make the most out of the programme. Conflicts readily arise between a concrete visual event and the abstract verbal information. When this ever happens, the concrete and readily accessible information assumes priority over the abstract information. In a similar way "bold", large and sudden movements take priority over less spectacular movements. A *contradictory relationship* exists when the data and the information in various channels conflicts. This is disastrous in information design and instruction design, but not always in persuasion design.

1.6 Receiver activities

In the receiving of a verbo-visual message, the receiver, or the “interpreter” will use several processes and reception tools. The processes are influenced by reception principles. All receiver processes are influenced by prior experience in relation to age and gender, as well as by cultural, economical, historical, political, religious, and social factors. Such experiences may all influence the selection processes, the mental processes, and the response processes. The influence of these factors may have a major impact on how different groups of receivers relate to verbo-visual messages of various kinds, and on how meaning is constructed.

1.6.1 Receiver processes

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. Messages may have different purposes. The reader should always be keen to question what the author, photographer, artist, editorial staff, intends with texts, pictures and images. Why is the message there? What is the function of the message? What is the main message in the picture? Which are the secondary meanings? Which associations does the message raise? All messages can cause a discussion and be used to train the critical thinking of the students. We should discuss what the senders want to achieve with the messages and how they can be used in different contexts. Search and selection tools include indexes, directories, catalogues, computers, databases, and libraries. We have to remember that all receivers are different.

The receiver’s mental processes include attention, perception, understanding, and learning principles, and are performed with sensory organs and the nervous system. The interpretation of an intended message will be influenced by the various experiences of the individual person. Often various individuals will interpret the same representation in completely different ways. Awareness and experience of the function of media in society are also important. (The receiver’s mental processes are discussed in Chapter 5 *Cognition*.)

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. However, in many situations it is not at all possible for the individual to give any feedback to the sender. Response tools include body language, verbal language, and visual language. 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 future messages. The receiver's response processes are not further discussed in this book.

1.6.2 Finding information

The possibility of finding some specific information is much higher when we are interested in finding that information. When we, for instance, 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. On a number of occasions I have asked subjects to write down the advertisements they could recall from the morning paper. Each time, only a few subjects could remember more than one or two advertisements so well that they could describe them in some detail.

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 place. We are good at remembering information we can relate to concrete, spatial concepts. One example is books in a library. 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. Some information is only useful to have at exactly the time we need it.

Thus, *when* we have access to information is an important factor. A daily paper, for example, quickly becomes out-of-date. Reading a three-day-old paper is usually not very interesting. As long as multimedia systems are expensive and not commonly accessible, it will be difficult for the ordinary user to gain access to information when she or he needs it. It is necessary to explore how, for instance, inexpensive optical storage media, like CD-ROM and CD-I, can make information available for large groups of people. We know that a text or a picture can give rise to many individual associations. People often make their own, individual interpretations of a text or of an image. However, why and how we make associations are not very well known.

We know that *context* is an important factor. Studies of why and how we associate are important for making it possible to design information systems where we can find the right information when we need it. It is almost impossible to predict which associations people will get in each specific situation. Thus there is an

obvious risk that also multimedia-systems will be created according to traditional ways of structuring information for print media like books and magazines.

Computer-based information systems have made it potentially easier to find information, but there are also factors which can make it harder to find exactly the information we are interested in. One reason is that we associate words differently, and give words different meanings depending on the context in which they appear. An example of this can be found in research on *visual literacy*. The Swedish word "bild" (visual, picture, image) has eight different meanings in the Swedish language, and also the word "färg" (colour) has eight definitions. Thus it is quite apparent that one may find a lot of superfluous information when searching for research papers in a bibliographic database.

Furthermore, it can be almost impossible to know that we have found everything of interest to us after a search in a hypermedia or multimedia system. 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 and may even be impossible. Being able to execute search questions is thus desirable for hypermedia systems as a complement to browsing and navigation by pointing at various items in the display and clicking on the right icons. In addition, it is important that the producer of a multimedia information system carefully plans *which* information to communicate, *how* and *when* to communicate it.

The amount of available information is growing every day. Modern research and development produce more information than ever before in our history. This growth of available information 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. Twenty years ago, one person could have a good grasp of topics like "optical media" and "multimedia". Now, however, it is impossible to know everything that is going on within these areas. As the amount of information grows and becomes easier and cheaper to store, the need for new ways of navigating and browsing increases.

It is possible to distinguish between different categories of variables, or "dimensions", related to the navigation, browsing, and search for information in multimedia systems, as well as in other information systems. *Navigation* is a goal driven search for some specific information, usually in a database or in a multimedia system. Navigation is a combination of visual, "human" browsing and computer based search. *Browsing* is a rather ad hoc, random way for a visual, "human", search for information. We can browse through information stored in a database in a way which is similar to browsing through a book, a newspaper, or an encyclopedia. *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 the following four dimensions:

1. Type of search and how to find information: from a regulated and restricted search to an unregulated and flexible search.
2. Experience and perception of information: from a directed and intended to a free and associative experience and perception.
3. Structure and organization of information: from linear positions in a defined order to non-linear positions in a flexible structure.
4. Type of signs and code-system for representation of information: from abstract alphanumeric characters, letters and figures to images.

Every specific representation can be categorized by assigning a value for each of the above dimensions. An information navigation diagram showing these dimensions can tell us how different media are related to each other. The diagram can be used both for analysing existing information systems, and for predicting the characteristics of future systems. In an ideal information system it is easy to browse, navigate, and search for information. Such a system should have unregulated search, free and associative experience, and make it possible to navigate in a non-linear structure. It should be possible to search using both images and alphanumeric characters.

Hypertext is text, not constrained to be linear, containing links to other texts within a document or between two or more documents. Quite often hypertext documents and hypertext structures also include graphics and other pictures. Hypermedia, or “multimedia hypertext”, may include text, graphics, animation, sound and even video. In hypertext and hypermedia structures the links are usually indicated with “anchors”, special areas in a text or on a display. Clicking the mouse on an anchor causes the link to be followed to the anchor at the other end. After a while it is quite easy to get totally lost among all the information, and among the documents stored in a hypertext structure. Many readers may find various hypertext and hypermedia structures disorienting and difficult to navigate through.

1.7 Information design principles

Facilitating learning, providing a clear structure of a message, providing clarity, simplicity, unity, securing a high quality of the message, and limiting the total costs are all important *functional principles* for the presentation of clear verbo-visual messages in any medium. Harmony and proportion are *aesthetic principles*. The producer of information and learning materials can facilitate communication, and

the various interpretation and learning processes of the receivers or interpreters. Complicated language, in both texts and pictures, will impair the understanding of any intended message. Thus, text and pictures for information should always be designed so that they are easy to read. Any *graphical message* should be (1) legible, (2) readable, and also (3) well worth reading for the intended audience. Good legibility is usually easy to achieve. Any *audial message* should be (1) audible, (2) distinct, and also (3) well worth listening to for the intended audience.

The goal in information and instruction design should always be *clarity of communication*. The message must be accurately developed and transmitted by the sender or information provider and then correctly interpreted and understood by the receiver or interpreter. The main principles are briefly presented on the following pages.

1.7.1 Facilitating interpretation and learning

Fleming and Levie (1978, 1993) provided about two hundred “principles” for instructional message design. Here the main focus is on the receiver. These principles are related to the receiver’s attention, perception, memory, concept learning, and attitude change. The literature on attention and perception is vast and ranges from fine-grained psycho-physiological work on pre-attentive processes to the more general study of the perception and interpretation of illustration, text, and speech. Among the thousands of stimuli in the external context we only see, hear, smell, feel, taste, or pay attention to one stimulus at a time. There are always far more stimuli than we can ever notice at any given situation. Most stimuli remain unknown, unseen and unheard of.

Perception is always organized and it tends to be holistic rather than detail-oriented. We perceptually construct relationships of objects, events, words, and people. We see dots, lines, areas, light, and dark in an organized way. One of the most simple perceptual organizations is that of “figure and background”, or simply “figure and ground”. Some elements in a picture are selected as the figure, and the remaining elements constitute the background. Learning is a complex phenomena. It may be defined as a set of processes by which relatively permanent changes in behaviour occur as a result of practice or experience. The result of the learning processes can be noted by observing changes in a person’s or in an animal’s behaviour. It can also be seen via neurophysiological changes. (See Chapter 5 *Cognition* for further information.)

1.7.2 Information structure

The physical act of writing and drawing one's thoughts with the help of a pen and paper, a keyboard, or a mouse and a computer, does not usually require a great deal of time. It generally takes more time to work out what the text and the pictures should consist of than to formulate the contents. Thus, the writing and drawing processes encompass much more than merely writing and drawing, and they are relatively independent of the language used. There are many different areas of human knowledge. Some areas concern technology, others concern art and aesthetics. Some areas are large or even very large, others are small. Some areas are well established, others are new.

Areas of knowledge may be divided in sub-areas, which in turn may be divided in groups and subgroups, and so on. These sub-areas and subgroups may have many different kinds of relationships to one another. Before we can create an information or learning material it is important that we decide *which area* and *which sub-areas* as well as *which kind of relationships* we need to describe for the intended audience. There may be different kinds of relationships between the whole and the parts within an area of knowledge, and between the individual parts of that area.

Subject matter experts often spend far too much time and effort describing very small, and only for them, “interesting” details because they happen to have easy access to information about these details. Before starting to write or draw, it is important to decide which *level of detail* we need to work on.

1.7.2.1 Perspectives

We can sometimes study a specific area of art, science, technology, a specific product, a specific service, and a specific system from several different perspectives or viewpoints. Depending on our choice of perspective our impressions will be different. A manufacturer, a sales person, and a user will need different types of documentation, with different texts and different illustrations as representations of the same product or service. Before starting to write or draw, it is important to *decide which perspective* we need to provide. It is important that it is easy to gain a *general understanding* of every topic.

A well-structured printed learning material is divided into chapters and sections that 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 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.

1.7.2.2 *Selection of information*

Conveying redundant information with text and pictures facilitates information processing, reduces error and information loss, and increases the amount of information that learners can recall. Text and pictures make it possible for the learners to alternate between functionally independent, though interconnected and complementary cognitive processing systems. In the production of information and learning materials this is not always the case. Evans, Watson, and Willows (1987) interviewed editors, art directors, and graphic designers from nine major Canadian publishing houses. Then they concluded (p. 90):

Our interviews confirm Dwyer's (1972) summary that the selection and inclusion of illustrations in textbooks appear to be based on "subjective feelings of the designer about what is best, the accessibility of raw information, the availability of materials, the cost, the attractiveness of the finished product, and the availability of a ready market" (p. 16).

Results from several experiments show that learning is facilitated and maximized when text and pictures contain the same or similar information. Marsh (1983) provided the following guidelines for selecting a visual channel (rather than a verbal channel) for a message (p.101):

- When messages are complex.
- When referability is important.
- When messages are long.
- When environment is noisy.
- When arrangement is complicated.
- When precise spatial discrimination is important.
- When simultaneous presentation is desired.
- When more dimensions are required.

The same visuals are not equally effective for learners in different grade levels, and for learners with different prior knowledge. Selection of artistic style for visual materials should not be an arbitrary decision, but always a conscious one. Visuals for information should be attractive but "unambiguous", not too "artistic" and therefore ambiguous. Visuals that are attractive and that people like also have greater impact. To increase interest in a specific material it might be a good idea to use a blend of several kinds of pictures, such as diagrams, drawings and photographs. Generally speaking it is not possible to rank the importance of different types of pictures. Often the type of visual which should be used must be determined in each specific case, with a view to various demands on the picture and also on the budget. It is often easier to control the production of a drawing than the production of a photograph. So a drawing may be the only realistic alternative

in many instances. Effective visuals for information should create an experience for the reader. The reader must:

- See, or rather “discover” the picture.
- Pay attention to the picture.
- Actually read the picture in an active and selective way.
- Mentally process the information in the picture.
- Make use of the information in the picture.

Visuals may cost a lot of money. But a “good” picture need not cost more than a “poor” picture! Spending a lot of time on the visualization process and on sketches (usually a less expensive process than the cost of originals, “masters”, and print runs) may therefore be worthwhile.

1.7.3 Clarity

The graphical message’s *legibility* is determined by the technical design of the text and the pictures, that is, their *clarity*. Legibility can be measured rather objectively, and its quality may very well be assessable whether we understand its content or not. (This is noted in the next sub-section.)

1.7.3.1 *Legibility of text*

As far as the text is concerned, we should avoid unusual typefaces, as well as typefaces that are too small or too large. Typeface and font size must be adapted partly to the medium and partly to the choice of technical production. We read words in a text as “pictures”, not letter by letter. In a book it might be sufficient to set the type between nine and twelve points, although on a display screen, the text should be at least three to five times as large. The text on a poster meant to be read from some distance may need to be ten times greater in size. Here is an example of a text with rather poor legibility:

Example 1.1 With respect to width and line thickness a character can be designed in different versions. A typeface may be available as light condensed, light, light expanded, bold condensed, bold, bold expanded, regular condensed, regular, regular expanded, extra bold condensed, extra bold, and extra bold expanded. With respect to inclination a typeface may be designed in italic letter style versions. A typeface may also be available as outlined, inlined, and shadowed. The visual weight, or visual impression vary. It may be compared with physical weight. A small and extra bold and expanded character may be seen as heavier than a large, light and condensed character.

To achieve optimum legibility it is known that regular type is easier to read than uncommon type. Boldface or italics should normally not be used for continuous text. Italic print is read more slowly than regular type and is also disliked by many readers (Tinker 1965). However, boldface and italics may be used for *emphasis*. Italics may be used for small parts in a running text, for headings, and for legends. Bold type may be used for headings. Different style manuals have different

recommendations for when italic and bold type versions should and shouldn't be used. The use of underlining and all capital letters should be restricted to headings and titles, if they are used at all. Usually bold and italics are quite sufficient. Underlining in the middle of a sentence makes the lower line more difficult to read (Isaacs 1987). Shadow, outline letters, and reverse type like white type on black background should be avoided because they are hard to read.

In this text example, Times is set in seven point type. For most people this is too small for a normal running text. The running text in this book is set with Minion 10.5 point type, and it has good legibility. (See Chapter 4 *Graphic design* for further information about legibility of text.) Also in oral presentations it is important that it is easy to clearly hear the individual words and sentences. Legibility in the written message is comparable to *audibility* in the spoken message.

1.7.3.2 Legibility of visuals

Pictures that are used for information should also have good legibility. A schematic drawing has good legibility if it is easy to read (Figure 1.9).

Wileman (1993) provided the following checklist with questions for evaluation of visuals with reference to clarity (p. 86):

1. Are the words and images *large enough* to see?
2. Are the words and images *bold enough* to see?
3. Is there *good contrast* between figure and ground?
4. Is the visual *appropriate* for the intended audience?
5. What visual devices are used to direct the viewer's attention?
6. Does the visual contain only the essential information?
7. Are appropriate visual sequencing techniques used to present complex ideas?

In information design it is always a good idea to use this kind of checklist in order to achieve clarity.

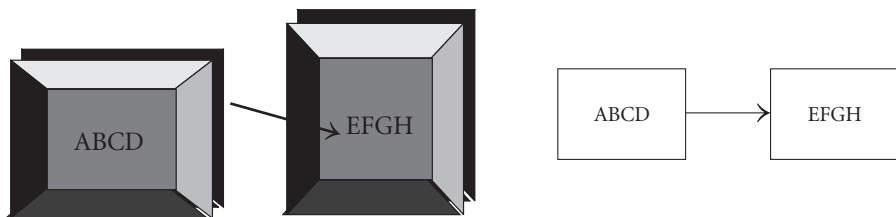


Figure 1.9 Poor and good legibility. An example of a simple schematic picture with poor legibility (left). This “style” is quite common in technical illustrations. When colour is used in this kind of false three-dimensional pictures, legibility may be even worse than in this example. It is hard to read the message. The second illustration (right) carries the same content. However, in this illustration it is easy to read the message.

1.7.4 Simplicity

The subject matter in 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 or the combination of spelling, grammar, and syntax as the *style*. The choice of words, expressions, symbols, and picture elements creates the style. A writing style that includes abstract words, long and complex sentences, stilted language, jargon, and passive constructions may obstruct the reading of the text. A drawing style that includes many different kinds of patterns, shadings, and lines, and inconsistent use of symbols may obstruct the reading of the pictures. A few guidelines may be used to enhance *readability* of text, as well as readability of pictures.

- Keep it simple! Leave out needless words, needless pictures and needless picture elements.
- Be clear and precise! Choose words and illustrations carefully.
- Be consistent! Inconsistencies will confuse the readers.
- Always write legends to explain the intended meaning of pictures.
- Make text and illustrations elegant and easy to read.
- Emphasise effective headings in a consistent way!

Some aspects of style, like “easy to read” will also include the clarity of text and visuals.

1.7.4.1 *Readability of text*

The readability of a message involves the reader’s ability to understand the text and the pictures. Readability is determined by the content and its presentation, and depends on how well adapted the content is to the receiver’s capacity to understand it. The writer and the picture-maker need to take into account the reader’s knowledge, interests, and needs in order to compile, sort, and structure the material. This is also true with regard to the formulation of texts and pictures. The following text is an example of a text with poor readability:

It actually has been seen to be well established, in several separate contexts, in several different experiments, that it is of a not obscure, but rather a question of completely decisive significance *how* we converse with different people, whom we happen to meet in our environment, and how we formulate our way of writing to, or for, these personages, in all varieties of contexts and scenarios that we feel may be important at the time. That information always should be correct is obviously something that we, generally speaking, can contemplate as to be a truism for us all, just as we can easily observe that each discrete piece of information should be clear and unequivocal so that the reader or listener or watcher does not, either wholly or to some part, misunderstand what we actually mean when we will convey a specific message. But that the said information should also be *under-*

standable, and therefore easy to understand for everyone in the designated target audience or receiver audience, is unfortunately not yet for all, or even a majority, of our different colleagues, or other persons on whom we can be dependent, in one way or another, understood to its fullest extent.

Unfortunately, this kind of blown up and pompous text is far too common in technical as well as in scientific documentation. In the following example the above text has been edited. This new text version has good readability and it still retains the main message:

How we speak with and write to each other is very important. It is obvious that information must be correct, just as it must be clear and unambiguous. But that it should be understandable is something that not everyone understands.

People may simply avoid materials that they find difficult and too pompous. Klare (1985) concluded that simple, active, affirmative, and declarative sentences are the most readable. In most cases improved readability results in greater reading efficiency, increased reader acceptability and better comprehension, understanding and learning.

Also in oral presentations it is important that the listeners understands the words. Readability in the written message is comparable to *distinctness* in the spoken message.

1.7.4.2 Readability of visuals

A schematic picture has good readability if it is easy for the reader to understand the message. The readability is determined by content and formulations, and how well the language and style is adapted to the readers. Wileman (1993) and a number of other authors have described different methods for the editing of visuals so as to change their importance and impact. We may crop or expand the original picture. Parts of the picture can be deleted, added, altered, moved, or changed in shape or position. The picture can be enlarged or reduced. A colour can be changed, removed, or added. The picture's expressiveness can be altered by the choice of reproduction method. (See the sub-section 3.3.10 *Picture editing* for further information.)

Preference for a particular visual format does not necessarily result in increased learning. Yet, in the absence of more substantial data, information based on student preference has a meaningful role to play in affecting interpretation and learning from information materials and instructional texts. All other things being equal, we should provide formats which are preferred by the viewer, thus making the text more attractive, and hopefully more motivating (Figure 1.10).

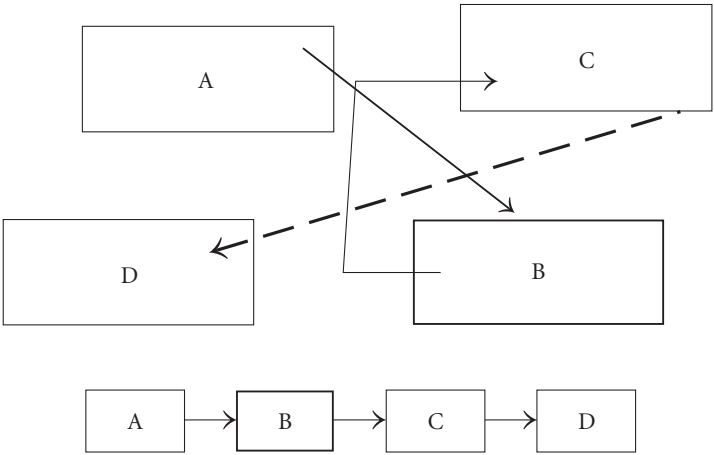


Figure 1.10 Poor and good readability. The upper illustration is a simple example of a schematic picture with poor readability. It takes some time to figure out the relationships between the four picture elements A, B, C, and D. The lower illustration is an example of a schematic picture with good readability. The content is the same as in the upper illustration. However, here it is much easier to see the relationships between the picture elements A, B, C, and D.

1.7.5 Unity

In information design, instruction design, as well as in persuasive design unity suggests an “overall togetherness”. Some authors claim that 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 our 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. 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 legend. 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.

Visuals designed to complement oral and printed instruction should both have a high correlation with the message they are attempting to support, and need to be designed to provide the learning environment with specific types of stimuli needed by particular types of learners, to achieve special educational objectives. Wileman (1993) provided the following checklist for evaluation of visuals with reference to unity (p. 93):

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

Glynn, Britton, and Tillman (1985) reviewed studies on the effect of “typographic cuing”, in this case the use of (1) bold, (2) italic type, and (3) underlining, to signal the important ideas in a text, on learning. They found that this kind of cuing attracts attention to the cued material. Readers are more likely to remember cued ideas than uncued ideas. In an information material unity can be achieved by the consistent use of specially designed templates for typography and layout.

1.7.6 Securing quality

When we design information, learning and teaching materials, it is important that the materials always are reviewed and approved by people who have *expert knowl-*

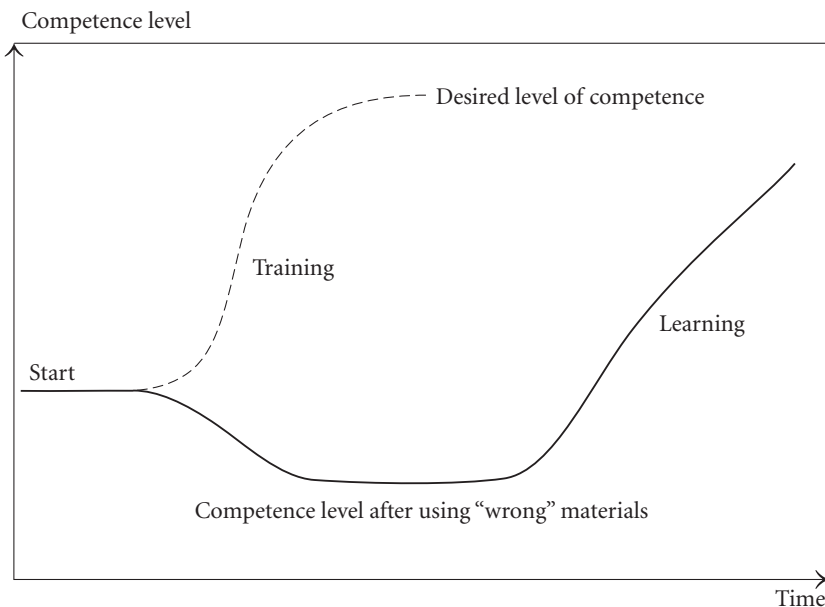


Figure 1.11 Competence. In the worst case, instruction, teaching, training and use of information and learning materials which is incorrect or irrelevant can result in a lower level of competence, greatly increase the costs, and severely delay projects.

edge in the appropriate fields. The efforts that we put into instruction, training and learning may give a *negative result*, and the learner may actually end up *less competent* than before teaching started (Figure 1.11). This may happen when we use teaching and learning materials with poor quality. A poor quality information material includes one or more of the following characteristics.

- It is technically incorrect or irrelevant, it provides the wrong content, and it has “deadwood”. Thus it is misleading.
- It is badly structured and therefore it is hard to understand.
- It has poor legibility, and therefore it is hard or impossible to read.
- It has poor readability, and therefore it is hard to understand.
- It has low reading value, and it is not at all worth reading for the intended audience, and therefore it is not interesting.
- It has confusing and misleading pictures, not at all relevant to the content of the text. Thus it is misleading and confusing.
- It has a writing style that is inconsistent and does not conform to an expected standard. Thus it is confusing.
- It is not consistent throughout all its chapters and sections with respect to text, pictures, typography and layout. Thus it is confusing.
- It is un-grammatical, badly spelt, and incorrectly punctuated.

Persson (1999:5) noted that research has shown that teaching without knowledge about the dynamics and variations of the learning processes may have an opposite effect than the one intended (see Persson 1996a, 1996b, 1997a; Rosenfeld & Jarrard 1986). Unfortunately, these situations may be common in information, education and training today. Using the “wrong” materials and instructions 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 kinds of documents to be used for information, learning and training purposes are technically correct and relevant to the specific situation. The training and competence development departments should be responsible for ensuring that all information and learning materials are well-structured and understandable, highly legible and readable, and have a high reading value. The production departments should be responsible for ensuring that, in all information and learning materials:

- Language is used in a consistent fashion.
- Style is used in a consistent fashion.
- The correct terminology is used.
- Typography and layout is correctly used.

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 teaching materials, 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. The aim must always be that learning materials and other documentation to be used for learning and training purposes receives approval. That is, the legibility, readability, and reading value of the learning materials are approved. 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. As noted in the next sub-section this will often pay back very well in less time and less costs used for reading, understanding and learning.

1.7.7 Limiting the total costs

When many people are to read and understand information during working hours, the cost 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 read certain information, the greater the cost. The cost of reading is determined by the type of documents that will be read, 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. In the handbook called *Plain Talk from the Cabinet Office*, that is provided for use by members of that body in Sweden, Ehrenberg-Sundin (1982) stated that judicious planning of texts can save millions of crowns for the government. (One Swedish crown is approximately 1/8 of a US dollar.) Ehrenberg-Sundin writes as follows (in translation):

It is expensive to *read* texts! The cost of reading is often many times greater than the cost of writing and printing the material. Besides, if readers do not *understand* the text, or if they interpret it incorrectly, it becomes *VERY expensive!* This problem can be solved by planning text better. It should have a *purpose* and the selection of its content *must agree with that purpose*. Thus, we can avoid the greatest reading expense. If we help the reader further by writing *comprehensible language* and giving the text a sensible presentation as well as an arrangement that is logical to him, we shall have saved still *more time and money*.

The cost of reading and understanding text and pictures is in most cases many times greater than the cost of producing the information materials. Ehrenberg-Sundin offers an estimate:

For a report that has cost Sw.cr. 80,000 to print and just as much to write (four months' salary for a committee secretary), the cost of reading it will be Sw.cr.

1,600,000 if 1,000 persons spend eight working hours each (at Sw.cr. 200 per hour) to read and understand it. The greater the number of people who are meant to read a text, the greater the incentive is to expend extra effort on making it easy to read!

In private companies, the cost per hour is usually reckoned at Sw.cr. 400 or more, instead of Sw.cr. 200. (Since 1982, these costs have increased considerably due to inflation. However, the ratios remain the same.) Thus, in industry, savings in this area can be greater than in the public sector. Melin and others (1986) refer to a cost estimate that was carried out at the Swedish Telecommunications Administration (now Telia). The total cost of a 20-page technical report was estimated in Sw.cr. per page as follows: writing 5.60, printing 1.40, storage 25.00, and reading 225.00. In other words, the cost of reading the report was many times greater than all the other costs put together. The author's work on the text represented only two percent of the total cost.

1.7.8 Copyright

The rights of copyright holders are protected according to (1) international conventions, (2) terms of delivery and (3) agreed ethical rules. Terms of delivery and ethical rules may vary within each country, or even within each region of a country. Full copyright protection for a "work" or a "production" requires originality, creativity, and fixation. For texts and literary works the copyright protection duration is the length of the life of the author, plus another 70 years.

In many countries all kinds of pictures with any "artistic merit", or with any "scientific merit" enjoy protection for 70 years after the death of the copyright holder. Drawings usually belong to this category. In practice, also almost all photographs can be said to have at least some artistic merit and thus have protection for 70 years after the death of the copyright holder. It is usually hard to prove that a picture should be without any artistic or scientific merit.

When photographs are produced on commission, the client usually pays for and enjoys all copyright rights, including the rights to prints made from the original photographs. The client can freely utilise the commissioned pictures in any way that is desired. The publishing rights to archive photographs are usually bought for each specific publishing occasion. The buyer may not then transfer the publishing rights to a third party without a written permission from the copyright owner. This transfer may or it may not include any extra payment to the copyright owner. It is a matter of negotiating the terms.

As regards drawn illustrations and art work, the client usually pays for the actual work with sketching and drawing, for the work with the originals, and for the right to reproduce and publish the pictures in a particular publication. Then

the physical drawings, the originals, usually remain the property of the artist. If an original should be damaged or lost the artist usually becomes entitled to an economical compensation, equivalent to the “re-acquisition cost”.

The name of the picture creator or copyright holder should be stated in each printed document containing the pictures, preferably in direct conjunction with the pictures. I may also be sufficient to collect all these references and put them in a list at the beginning or at the end of the document.

1.8 Information design tools

In all verbo-visual communication we use different kinds of representations. Text, symbols, all kinds of pictures, typography, and layout are the main information and message design tools for lexi-visual representations. For production of audio-visual and multi-visual representations additional tools like animation, sound and sound effects may be used. There are different types of messages. Different combinations of linguistic expressions are usually employed in mass-communications. For example, a textbook or a newspaper generally uses both the printed word and pictures. A television programme, and a multimedia presentation employ words and images, and sounds, such as music. In an exhibition we may also make use of the space, as well as light and shadows.

However, pictures, computer images, movies and television programmes should never be confused with reality. They are only different representations and they always render a subjective, and selective view of reality. The “reality” of a printed page does not exist in real life, but only on the page itself. Cochran (1987) distinguished between actual events/objects, iconic re-presentations, and arbitrary representations. Examples of iconic representations are film and TV-images, still photographic pictures, and realistic art work. Symbols, signs, computer graphics, and words are all examples of arbitrary representations. Here, no cues from actuality are left. Doblin (1980) classified iconographic (visual) information into several categories: *ideogrammatic* (symbols that attempt to convey a single meaning, such as a road sign), *diagrammatic* (charts, graphs, or diagrams), and *isogrammatic* (photography, drawing, and drafting). Hunter, Crismore, and Pearson (1987) presented a classification as points along a continuum from realistic to abstract: photography, artwork, diagrams and maps, graphics and formulae, tables and charts, and orthography (icons). In their study on *Visual Displays in Basal Readers and Social Studies Textbooks*, they used the following categories: sequential graphs, quantitative graphs, maps, diagrams, tables and charts, and verbal-visual displays.

For Wileman (1993) all kinds of representations of any object are symbols. He argues that there are three major ways to represent objects – as *pictorial symbols*,

as *graphic symbols*, and as *verbal symbols* – ranging from concrete to abstract representations. The first group, pictorial symbols, includes photographs and illustrations or drawings. Viewers should easily 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 can be characterized as 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. Verbal symbols can be understood only by people who comprehend the language used to describe the objects.

However, in my view (Pettersson 1993) there seems to be no major difference in “abstractness” between the abstract arbitrary graphic symbols and the verbal symbols. Thus, I prefer to distinguish between two main categories of representations, (I) figurative representations, and (II) non-figurative representations in this way.

I. Figurative representations

1. Visuals
 - Three-dimensional images
 - Photographs
 - Drawings
 - Schematic pictures
2. Graphic symbols
 - Pictorial symbols
 - Abstract symbols
 - Arbitrary symbols

II. Non-figurative representations

1. Verbal symbols
 - Verbal descriptions
 - Nouns or labels
 - Letters or characters
2. Non-visual and non-verbal representations
 - Sounds
 - Odours and scents

CHAPTER 2

Text design

To succeed as writers we need to know our readers, the purpose of our writing, and how the message is to be conveyed to the readers. We need to understand how the concept of “literacy” has changed. We have a responsibility for our readers to write comprehensible and clear texts. We should use good structure, correct English, as well as a clear and consistent writing style. Good text design is simple and direct. In order to function well our messages need to have good credibility. Producing “messages” has a long history, all the way from cave paintings to the Web.

When a document is to be read and understood by several people, there is reason to expend effort on achieving a message of good quality. When this is achieved, we can discern the information’s aesthetic, informative, pedagogical, and technical qualities, and sometimes even its entertainment value. Good information quality can be defined as the degree of congruity between the sender’s and the receiver’s subjective perceptions of the material, as well as of the reality that the message represents. By investing resources in improving the quality of language and the quality of information, we can achieve better product and project quality, while, at the same time making large cost savings.

2.1 From cave paintings to the Web

Cave paintings, rock inscriptions, rock carvings, clay tablets, rune stones, church paintings, letters, and other hand-written material are all examples of unique documents conveying a direct message from the sender/writer/picture creator to the receiver/reader. However, these messages were sometimes intended for gods and other higher powers, not for ordinary people. Some cave paintings were made more than 30,000 years ago. Rock inscriptions and rock carvings go back some 3,000 years in time. Text and pictures have been produced, distributed, stored, and utilized for thousands of years. The first “travel guides” were produced and sold as early as 2000 B.C. They were the Egyptian “Books of the Dead” which contained advice and information, in an integrated, lexivisual amalgam of text and pictures, on coping with the trip to the Kingdom of Death. They were completely hand-made rolls of papyrus and, thanks to their high price, only available

to truly wealthy families. The trade in these books is reminiscent of the medieval Catholic Church's trade in letters of indulgence. Both phenomena are examples of what could be called profitable *publishing*. Duplicates were made in the most literal fashion imaginable by "middlemen", specially trained scribes and copiers who copied text and drawings, often repeatedly. The industrial production of books is a comparatively modern phenomenon.

Despite the fact that books began to be printed more than 500 years ago, printing remained an exclusive and painstaking handicraft for many years. Gutenberg's bible was printed on 316 pages and took three years to make (1452–1455) in an edition comprising 200 copies. Some 170 of these copies were printed on paper and 30 on parchment. A total of 5,000 calf skins were required for the parchment versions. One goatskin was needed to cover each book. Even at an early date, *libraries* of different kinds acquired major importance as "institutional middlemen" in the transmission of information from writers to readers. The first public library, Pisistratus, was founded more than 2,500 years ago (540 B.C.) in Athens. The first bookstore was opened, also in Athens, 140 years later (400 B.C.) Until the middle of the 19th century, bookstores often served as publishers, too, producing as well as selling books and other graphic products.

A great many people 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 different 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.

"What writing is to the reader, pictures are to those who cannot read" stated Pope Gregory the Great (540–604). Already by the Middle Ages, a wide spectrum of image types was already used for teaching and training. The pictures ranged from realistic drawings to abstract diagrams. Pictures were used for the identification of important medical herbs, for instruction on how to load and use a cannon, how to swim, how to fight with a sword, how to construct a building, and for training the art of angling. Manuals and instructions have been preserved since the 15th century. Mijksenaar and Westendorp (1999:21) mentioned a fencing manual by Hans Thalhoffer (1443) which includes visual instructions in wrestling and unarmed combat.

In Europe, the ability to print images on paper was achieved in the 14th century. The block book contained text that was written by hand and printed images. These printed images invariably included some form of captions or texts. When

the moveable type was introduced during the 15th century, it became possible to produce books in larger quantities. This was the beginning of a cultural revolution. A dramatic growth in the quantity and quality of books and other printed learning material, like maps followed. Informative drawings developed. However, the new printing technology impaired the possibilities for integration of words and visuals to verbo-visual messages.

In manuscripts it was easy to put words and visuals anywhere on a page. The skills of integrating words with visuals were gradually developed. Many famous naturalists and explorers have relied on making verbal as well as visual notes of their findings. The most noticeable example may be Leonardo da Vinci (1452–1519). He was one of the greatest artists of the Italian Renaissance. Leonardo da Vinci displayed genius in almost all arts and sciences, and his notebooks are filled with sketches of anatomical studies, animals, and machines. Nearly 7,000 pages from his notebooks still exist. He sketched ideas and inventions along with his notes. Leonardo da Vinci sketched drawings of ideas and inventions along with his verbal notes. His notes and sketches are unusual. Leonardo was left-handed and he used mirror writing in his notes. His script can be read clearly with the help of a mirror. The second unusual feature is the new function he gave to illustrations. Leonardo formulated his own principle of graphic presentation, which he called “*dimostrazione*” (demonstrations). He gave precedence to the illustration over the written word. The text served to explain the pictures. Leonardo was clearly a precursor of modern verbo-visual communication and of modern scientific illustration.

Another early example is the Flemish physician and anatomist Andreas Vesalius (1514–1564). He revolutionized the study of biology and the practice of medicine by his careful verbal and visual description of the anatomy of the human body. Based on observations of dissections he did in Padua and Bologna, he wrote the first comprehensive textbook of anatomy, *De humani corporis fabrica libri septem* (The Seven Books on the Structure of the Human Body) – known as the *Fabrica* – printed in 1543. In this book, art and anatomy are dramatically combined. The book was probably illustrated by one of Titian’s students. The illustrations provide a graphic, detailed record of the musculature and skeletal framework of the human body.

In more modern times, the first person to really show how visuals and words could interplay was the bishop Johannes Amos Comenius (1592–1670) of Moravia (later a part of Czechoslovakia). His illustrated textbook, *Orbis Sensualium Pictus* (The Visible World in Pictures), was first published in 1658. Comenius presented information on the world and on mankind in closely related pictures and words. The 150 illustrations, copper cuts from his own drawings, had numbers referred to in the text. In some later editions, the text was printed in four different lan-

guages. This book was widely used in both Europe and the USA for over 150 years. The first American edition was published in 1810, with texts in Latin and English. *Orbis Sensualium Pictus* is generally considered to be the first illustrated school-book, designed specifically for children. Comenius emphasized the importance of the senses in learning. His famous illustrated alphabet, combining letters, pictures, and “sounds”, and found in the opening pages, has later been adopted by many authors of ABC-books. In *Orbis Sensualium Pictus* the illustrations are actual teaching devices and not merely ornaments on the pages. Comenius preceded Diderot’s picture-volumes and the visualized fact books of today.

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 (Reynolds-Myers 1985; 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.”

The greatest early enterprise in visual information and in message design is the French encyclopedia *La Grande Encyclopédie*. The first volume appeared in 1751 under the co-editorship of Denis Diderot (1713–1784) and Jean d’Alembert (1717–1783). The *Encyclopédie* was a huge undertaking that occupied Diderot as chief editor for a quarter of a century. The *Encyclopédie* exerted great influence throughout the world. It was a genuinely progressive work with 17 volumes of text, supplemented by 11 volumes of illustrations. No less than 3,300 plates with detailed illustrations were designed and printed from copper engravings. The structure of the encyclopedia was based on Francis Bacon’s classification of universal knowledge, the most complete and systematic inventory of areas of knowledge and human achievement at that time. This assured representation of topics across the entire spectrum of knowledge. Articles were written by leading persons such as Rousseau, Turgot, Montesquieu, and Voltaire. The attitude was tolerant, liberal, and above all, rational.

The British explorer and naturalist Charles Darwin (1808–1882) developed the theory of evolution through natural selection. His book *On the Origin of Species by Means of Natural Selection* (1859) presented the facts on which he based his concept of gradual changes of plants and animals. Also today, combined verbal and visual information is very important in the natural sciences. In engineering, science, and business, clear thinking is often synonymous with visual thinking. Horton (1991) noted that Albert Einstein and several other highly valued thinkers relied on visual images. In many cases visuals may be the main source for information and communication today (Moore & Dwyer 1994).

From an instructional point of view, there was not much development in visual instructional language from the 15th until the 20th century. Mijksenaar and Westendorp (1999:22) concluded that:

The next major advance in visual instructions occurred during World War II, when the military used pictorial language to train soldiers. The Walt Disney Company, for instance, adapted its cartooning skills to create training documentation and films such as the movie employing Mickey Mouse to explain how to use a Browning.50 water-cooled machine gun. The defence industry in general also played a role in augmenting and applying visual instructional language during this period.

Throughout the 1980s, major changes occurred in the way our society produced, stored, processed, and accessed information. Monfils (1993) noted that regardless of the specific application of technology, consensus had been reached on the increasing impact of modern information technology on all aspects of our lives. The amount of available information is seen as increasing every day. Modern research and development produce more information than ever before. Our society views the availability of, and the need for information as the basis for decision-making as continually increasing. Frequently, people in a variety of occupational settings find that their basic knowledge is inadequate, while we can easily learn a little about a great many subjects. This kind of learning, leaves us with little more than a broad base of superficial knowledge. For some people, the ultimate goal actually seems to be to know a little something about everything, resulting in an altogether fragmented knowledge base.

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 the “Age of Information”. The pace of development is likely to increase rather than decrease in the future. It is possible that visual messages, and verbo-visual messages, in different forms will become increasingly important in the future when modern information technology like multimedia and the World Wide Web are common to most people. The web is a global information system on a worldwide public computer network, the Internet, independent of computer hardware, software and location. Modern systems for information technology often have user interfaces based on symbols and images. These systems are intended to function in various countries, in various cultures and subcultures.

2.2 Language models

According to semiotics, all cultural processes may be seen as communication processes (Eco 1971). Thus, there are different languages, such as spoken, written, and visual languages. Lotman (1973) suggested that any system used as a means of communications between people can be regarded as a language. Cochran (1987) concluded that humans cannot transfer ideas whole and intact from one person to another. Human communication depends upon an interactive series of successive approximations presented in metaphors. She found “*linguaging*” useful in directing attention to the actions of people as they share their own ideas, listen to others, or learn from technologically produced sights and sounds.

There are many approaches to language and language classification systems. Twyman (1982) pointed out that while linguistic scientists distinguish between spoken and written language, graphic designers distinguish between verbal and pictorial language (Figure 2.1). From a design point of view, written, printed, or displayed texts or verbal graphic language are important components of visible language. Twyman noted that examples of poor design which hinder the comprehension of text contents are far too commonplace.

However, if the linguistic representation (e.g., the medium and its content) is placed at the forefront, another approach is natural. In this model, linguistic differentiation is 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 are based on smell, taste, touch, etc (Figure 2.2).

Languages differ in their ability to express concepts with precision and flexibility. Physics, chemistry, 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. Languages such as these can only be understood by people with the appropriate specialized knowledge. Normal prose is often open to multiple interpretations, i.e., it is ambiguous. Fiction and poetry in particular offer abundant opportunities for individual interpretations. Pictures are normally ambiguous too.

In the animal world various body signals supply most of the communications between individuals. Animals send messages by displaying parts of their bodies in various ways. Message receivers “respond” with equivalent displays or movements. Bees have developed an advanced “*language*”. After returning to the hive, a bee can perform a dance informing other bees about, e.g., the location of a source of food.

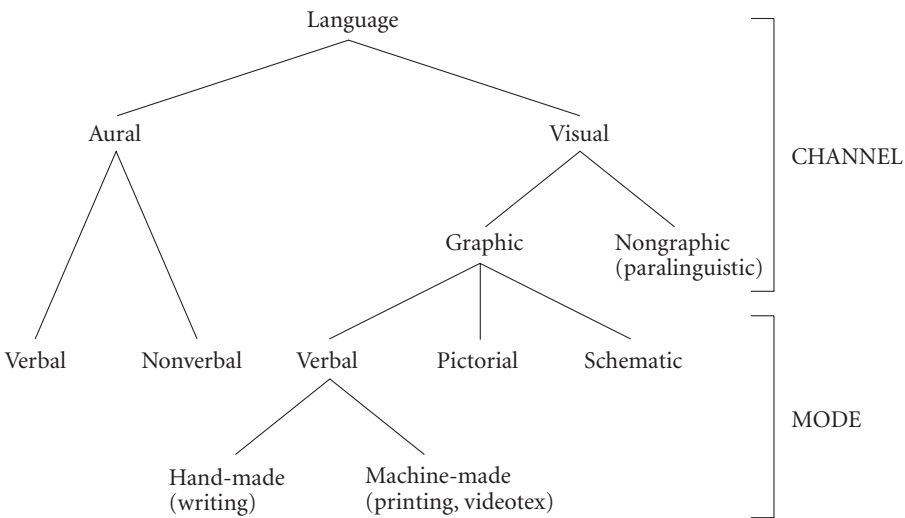


Figure 2.1 Language model 1. Twyman’s (1982) language model is devised to accommodate the approaches to language of linguistic scientists and graphic designers. Reproduced by permission of the author.

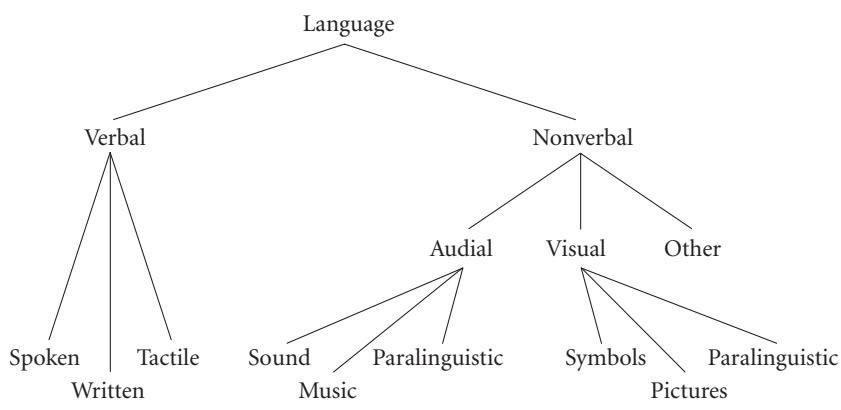


Figure 2.2 Language model 2. Pettersson’s (1989) language model is based on the form of representation. The model can be divided into additional sub-categories.

Body language and paralinguistic and extralinguistic signals are also important in Man. Some scientists suggest that body language accounts for up to half, or more, of all our communications with others. By the time we are adults we are all highly sensitive to the tiniest changes in expression, gesture, posture, and bodily adornment of our companions. We acquire this sensitivity through intuition rather than analysis. If we took the trouble to make a more analytical study of body appear-

ances, we could become even more sensitized to them, and could avoid some of the pitfalls into which our intuition sometimes leads us (Morris 1985).

Many movements and gestures can be interpreted without ambiguity in a given cultural community but not outside that community. In some societies, for example, the raising of an eyebrow, consciously or unconsciously, designates surprise. Or shrugging the shoulders designates indifference. But confusion and misunderstandings can occur before visitors to foreign cultures learn to understand the body language prevailing there.

Our body language is partly instinctive, partly learned and imitative (e.g., Fast 1971). An interesting fact is that bilingual persons change their body language, gestures, and eyelid movements when they switch (spoken) languages. Brun (1974) gives many examples of sign languages. We can see examples of “formal” signs almost every day. Deaf people are often very skilled in using their highly developed and structured visual verbal sign language. Other less sophisticated kinds of sign languages are used by, e.g., umpires in sporting events, traffic policemen, people directing aeroplanes on the ground, etc. Further examples are the sign languages used in the production of radio and television programs, and movies.

Thousands of alternatives are available to a sender wishing to transmit a rendition of some reality to receivers. Senders always utilize a “filter” and quality checks before selecting one of the many available text and picture options. The choice is based on the sender’s subjective opinions. The sender selects the option believed to be the most efficient for each purpose and each transmission situation. The selected pictures/texts are then edited in one of many ways for the purpose of enhancing reception impact. Thus, a selected, edited version of a representation of reality is transmitted to receivers. In mass communications, message reception can be affected in countless ways. For example, television reception may range from very bad to very good. Different viewers also perceive the same text and/or image in different ways, since there are always great inter-individual differences in perception (Pettersson 1986).

There is no unambiguous verbal or visual language. In a closed, homogeneous cultural group, “ordinary” pictures and texts probably give rise to similar interpretations and perceptions of a specific reality, single object, event, message, or content. However, we do not know the magnitude of the individual “tolerance ranges” in which different texts and pictures generate reasonably identical perceptions. One representation may produce accurate perception of content by one person but a completely different perception by another person. The context in which a message is seen can convey a “pre-understanding” of the message’s contents. Pre-understanding is vitally important to our perception of any message. The language we choose to use in any given situation is in itself a device conveying pre-understanding to the reader/listener/viewer. Message response is sometimes

easy to predict. This predictability is often heavily exploited in movies, television, and theatre.

Winn (1993) noted that a great deal of perceptual organization occurs preattentively, not under cognitive control. The way a message is organized, therefore, will have an important effect on the way the perceptual system structures what it detects and, in ways that the perceiver will not be aware of, on how that information is interpreted.

Perception of a given text/image by a random receiver in exactly the manner intended by the sender is unlikely. Senders, though, do not often require identical perception of transmitted messages by all receivers. A large number of approximate interpretations may suffice. A well-written explanatory and elucidating caption can enhance understanding of the content. One study (Melin 1986a) of student perception of texts and pictures in openings in a book where documentary and analytic pictures and descriptive texts interact showed that pictures were better at expressing contrast and specification and that texts were better at expressing logical relationships such as cause and effect. Some lexivisual presentations utilize the respective advantages of text and image.

2.3 Literacies

In the industrialized, cultural sphere, we are bombarded with information via the media, at home, in school, at work, and in the society in general. It is difficult at times to avoid information and it may be just as hard to obtain the information that we really need at the time. Audio, text, and visuals compete for our attention. It is quite possible that we miss the information in which we are really interested. In addition to radio, television, books, newspapers, and magazines, vast amounts of information are distributed in the form of advertising throwaways, posters, placards, and photocopies.

Throughout the 1980s, major changes occurred in the way our society produced, stored, and accessed information. Monfils (1993) concluded that regardless of the specific application of technology, consensus had been reached on the increasing impact of modern information technology on all aspects of our lives. Modern research and development produce more information than ever before and people frequently find that their knowledge is inadequate and fragmented. To be able to produce a verbal message in any medium, it is important to understand the possibilities and the restrictions of verbal language. We need to know how oral and written verbal languages are constructed and how they are perceived by various individuals.

Traditionally, the concept of *literacy* was restricted to the state of being *literate*. A *literate person* is one who is able to *read and write printed text*. Consequently, an illiterate person is unable to read and write. However, reading and writing means more than recognizing words; it also implies comprehending the meaning of the words that we read or write. During recent decades, however, people have recognized the need for a wide array of other “literacies” rather than a singular “literacy”, based on the traditional medium of print. Beyond the basic skills of reading, writing, and arithmetic, the citizen of the twenty-first century needs complex analytical skills. Dake (2000) argued that an important part of literacy is the development of flexibility and fluency of thought.

The tools of the Information Age have put vast volumes of information at our fingertips. According to Scott, Kirsch, and Jenkins (1998: 17) the 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”. Hugo and Skibbe (1991) argued that the illiterate of the future might not be those who cannot read, but those who cannot see.

Today the concept of literacy is much broader. Other literacies are computer literacy, cultural literacy, diagrammatic literacy, document literacy, economic literacy, environmental literacy, film literacy, information literacy, mathematical literacy, media literacy, music literacy, political literacy, scientific literacy, technical literacy, television literacy, video literacy, and visual literacy. Thus a person may be computer literate, culturally literate, diagrammatic literate, economically literate, environmentally literate, film literate, information literate, mathematically literate, media literate, musically literate, politically literate, scientifically literate, technically literate, television literate, video literate, and visually literate. Consequently a person may be illiterate in all these aspects, which would be hard in our modern society. We have, and indeed we fail to have many different literacies. Erstad (1998) pointed out that 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, what some educators term a social theory of media literacy. Information literacy is a potential tool of empowerment for all.

2.3.1 Computer literacy

Considine and Haley (1992) argued that computer literacy clearly relates both visual literacy and media literacy to the traditional concepts of literacy, namely reading and writing. Monfils (1993) argued that to be computer-literate one 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 well developed 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.

Modern computer systems often have user interfaces based on symbols intended to function in various countries, in various cultures and subcultures. These symbols may, however, actually not function at all for the intended users. Griffin et al. (1994) studied how international business people understood commonly used clip art graphic symbols. The symbols were taken from a Harvard Graphics software package for business presentations. Based on 4,530 opinions expressed by 302 subjects in Japan, Sweden, Tanzania and the USA, regarding 15 of the symbols in the software package, Griffin et al. made the following two conclusions:

- There are many ways to interpret symbols. Very few people share the same understanding of any given symbol.
- There are strong cultural differences in interpreting the meanings of symbols.

Computer users should demand better graphical interfaces as well as better instructions for use. Better user interfaces would probably fast increase the number of computer literate users.

2.3.2 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.

2.3.3 Information literacy

From a terminological point of view the concept “information” may be placed somewhere between the concepts “data” and “knowledge”. It is not easy to draw strict borderlines between these concepts. We may view information from various perspectives with respect to how we create, present, produce, distribute, search, sort, index, store, receive, process, value, respond to, make use of, and renew information. Often several groups of people with different skills are needed for these activities. Each person has a set of individual experiences and values which will influence their view of information. Vickery and Vickery (1987) pointed out that information is a 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, ...

Most people are involved with communication and with communication systems in one way or another. Some of these systems have “soft” and human or linguistic dimensions. Other systems possess “hard” and technological dimensions. Within library and information science some research areas are well established since many years. Other areas are relatively new and can be regarded as independent scientific disciplines. In several instances certain issues are addressed in different disciplines, even if the approaches may vary.

Research in library and information science (Höglund 1995) emphasizes the conveying of information and culture that is stored in any kind of document. Research projects range from historical and social aspects of information, to modern information technology like multimedia, the web, and other information tools on the Internet. Several home pages include graphics and image maps with hyperlinks to related information. Image maps range from very simple to very complex, from simple schematic pictures to works of art. 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.

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. According to Senn Breivik and Jones (1993), 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.

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. An information literate person has *information competence*, and accesses, evaluates and uses information in a qualified way. An information literate person:

- 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

Doyle (1994) 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. 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”. 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.
- 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. Information literacy programs encourage 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).

2.3.4 Media literacy

Sutton (1992) noted the similarities between information literacy, media literacy, and visual literacy. In a discussion on the evolution of imagery technologies, Fretette (1993) cited Loveless (1992), who wrote about the evolution of media technologies and identified their changing effects on consciousness, and their parallel role in redefining the traditional concept of literacy. Loveless suggested that the children of the future will need to 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 definition of literacy must include much more than traditional reading and writing. Traditional literacy is not enough any more.

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. Media literacy may be defined as the ability to access, experience, evaluate and produce media products. The main principle of media literacy is that media *represent* actual events. Journalists select which stories to tell, what to tell, and how to tell them. There is always one or more persons with their subjective views behind all representations. Each medium has unique aesthetics, codes and conventions. People have to learn how media are made and how they function. Each person bring 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 (Pettersson 1996). Today, curricula for media education have been developed in many countries. There are also teaching aids, like books and videocassettes. Key concepts of media education include questions like the following:

- Who is the sender?
- Who is the receiver?
- What type of message is it?

- What type of media is used?
- How is the message produced?
- What kinds of technologies are available?

The pace of development of information technology is likely to increase rather than decrease in the future. Visual messages, and verbo-visual messages, in varying forms will become increasingly important. Enser (1995) noted that we now belong to a society experiencing technological advances which are serving to promote the importance of the *visual medium* for message transmission and knowledge representation. I agree with Enser that this is a paradigm shift offering both opportunities and challenges, especially for the education and information professions. I also foresee two other paradigm shifts. In the future we will probably focus more on the *information content* rather than on the documents as such. We will also see a shift from emphasis on teaching to *emphasis on learning*. In this context it may also be noted that Malmberg (1996) pointed out that the culture industry transforms pleasure into mere entertainment and a *society of entertainment* is emerging.

2.3.5 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”. The essential competencies of critical television viewing skills are:

- To understand the psychological implications of commercials.
- To distinguish fact from fiction.
- To recognize and appreciate differing or opposing points of view, or both.
- To develop an understanding of the style and content of dramatic presentations, documentaries, public affairs, news, and other television programming.
- To understand the relationship between television programming and the printed word.

Gray concluded that programmes for critical television viewing skills can 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. In Sweden Findahl and Højjer (1979, 1980, 1984) demonstrated that radio listeners and television viewers sometimes had great difficulties in comprehending broadcasted news. The news content was badly organised, and the language was complicated.

Critical television viewing skills could also be called “television literacy”. The term television literacy has been widely used in recent years, both by researchers

and by educators. The program *Media Literacy: Teaching about Television by Teaching for Results* touch on the following three key concepts of television literacy (Media Literacy 1998):

1. **Television is an artificial construct.** Television does not present a reflection of reality; rather, its images are representations of reality. Television has its own conventions, its own grammar; the success of a television production depends on how carefully it is crafted.
2. **Television has commercial implications.** Television is a profit-centred enterprise. Programs are judged by the size of the audience they generate and by the market they offer the advertiser. Programs that do not turn a profit – educational fare, documentaries, civic forums – inevitably lose out to entertainment programs that do.
3. **Television is the prime conveyor of popular culture.** Television narratives convey a number of implicit and explicit ideological messages; these messages suggest what and who is important, and are generally representative of the values held by the dominant groups in society.

Buckingham (1993) argued that the notion of television literacy is far from straightforward in the present discussion. Television literacy bring forth a number of theoretical questions. Television literacy can be defined in many ways. Buckingham sees television literacy mainly as a powerful metaphor.

2.3.6 Diagrammatic literacy

Allmendinger (1998) argued that people use the same high level skills when they read diagrams as when they read prose. Reading diagrams involves perception, domain knowledge, narrative, motivation and bias, as well as social consensus. Diagrams are visual models representing data. They depend on point, line, plane, volume, value, colour, and texture, as well as text. Each visual element corresponds to something in the real world. Allmendinger pointed out that relationships between visual elements in a diagram mirror relationships between actual objects in the real world. According to Allmendinger (1998) diagrammatic literacy is a matter of getting people to make better decisions based on fairly sophisticated graphics information.

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. In a study in Australia Lowe (1993) found that experts and novices apply different mental strategies when they read diagrams. The experts base their in-

terpretations on underlying principles and domain based categories. Beginners, however, rely more on visual patterns in the diagrams. So far there are no universal conventions for the creation of diagrams or schematic pictures. This is, however, needed.

2.3.7 Visual literacy

Although the term “visual literacy” may be modern, it is not a new idea. Discussions about the use of images have a long history. Ancient philosophers used images for visual communication. In anatomy and medicine, Aristotle employed anatomical illustrations. In mathematics, Phythagoras, Socrates, and Plato used visual images to teach geometry. Jesus Christ and other religious educators and prophets helped their listeners create inner images by the use of different metaphors. In Mesoamerica, the old cultures and civilizations used advanced pictorial messages, especially in their temple cities.

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. 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).”

There has been, and there still are considerable disagreements concerning a definition of visual literacy. It is clear that it is difficult to describe verbally a concept that is primarily nonverbal. Over time, definitions have varied from very narrow to very broad explanations of greater or lesser complexity. A number of researchers have practically rejected the whole concept of visual literacy. Heinich, Molenda, and Russell (1982) recognized that there are different aspects of visual literacy. They compared visual literacy with print literacy and offered the following definition (p. 62):

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.

In my opinion this is a very good definition of visual literacy. The definition reflects the perspective that visual literacy is a concept in which particular skills, knowledge, and attitudes can be taught and learned, which enhance our abilities to communicate.

The International Visual Literacy Association, IVLA, was established as a non-profit association 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 who are interested in visual literacy. IVLA provides the following four “official definitions” of visual literacy (printed on official leaflet 1989):

1. A group of vision competencies a human being can develop by seeing and at the same time having and integrating other sensory experiences.
2. The learned ability to interpret the communication of visual symbols (images), and to create messages using visual symbols.
3. The ability to translate visual images into verbal language and vice versa.
4. The ability to search for and evaluate visual information in visual media.

Debes (1969) identified 35 different visual literacy skills. These skills range from the ability to distinguish light from dark to the ability to read and express a sequence of body language arranged to express a personal emotion. In the work of Fransecky and Debes (1972) the objectives for the visually literate student are (p. 12):

- To be able to read visuals made for intentional communication.
- To be able to plan visuals for intentional communication.
- To be able to create visuals for intentional communication.
- To be able to combine visuals and verbals for intentional communication.

Thus, according to Fransecky and Debes, the competencies of visual literacy are defined as *reading*, *planning* and *creating* visuals, and *combining* visuals and verbals for intentional communication. Esdale and Robinson (1982) argued that visual literacy should be integrated across all curricular areas in an effort to both expand ability and to prevent categorization which could limit learning and the use of visual literacy skills.

Schiller (1987) argued that all the different viewpoints of visual literacy show that every visual medium has its own characteristic form. Thus, there are clearly different visual literacies, and there are different skills to be learned in terms of their characteristic techniques and methods of expression. As a consequence people should concentrate on more limited concepts, such as computer literacy, film literacy, video literacy, and television literacy. Indeed, it might be impossible to create one single definition of the broad concept of visual literacy.

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. Schiffman (1995) 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 (p. 76):

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.

Paquin (1999) discussed “competencies of visual literacy”. He combined visual literacy skill perspectives of Fransecky and Debes (1972), Hansen (1989), and Seels (1994), with the visual literacy outcome perspective, proposed by Ragan (1988). Paquin made an “expanded taxonomy of visual literacy outcomes” (p. 247). The “expansion” is the addition of outcomes that require combining of visuals and verbals for successful visual communication. In the list below these expansions are marked with this sign*.

An expanded taxonomy of visual literacy outcomes

A. Primary Level

1. *Manipulation:*
Holding, touching and changing objects in the environment.
2. *Construction:*
Creating simple works, paintings, cut outs.
Taking pictures.
3. *Abstractions:*
* Identification of concepts – sizes, shapes, colours, names with objects, etc.

B. Skilled Level

1. *Manipulation:*
Using tools for problem solving; legos, sewing, taking apart and reassembling things.
* Sequencing/describing photographs.
2. *Construction:*
Drawing with perspective.
Controlling variables when taking/processing pictures.
Origami or other complex constructions.
* Interpreting/following mixed instructions.

3. *Abstractions:*

Creating visual plans/patterns in two dimensions.

Specifying photographic treatment for objects, actions and sequences.

* Creating visuals from verbals and vice – versa.

C. Advanced Level

1. *Manipulation:*

Mental manipulations of complex representations; maps, multivariate statistical models.

2. *Construction:*

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.

3. *Abstractions:*

Multiple holistic appositional forms of abstract thought; lateral thinking, visual intuition, unique visual invention.

* Describe conceptual visual ideas verbally.

It may be concluded that visual literacy is a broad and interdisciplinary concept including theoretical perspectives, visual language perspectives, presentational perspectives, technological development, and bits and pieces from several other “established fields” of research. Despite all the efforts during the past 30 years visual literacy and the “visual literacy movement” has not been able to attract enough interest from society and from those responsible for school curricula. An important reason may be a general lack of focus.

2.4 Comprehensibility

Squires and Ross (1990) found that in one industry sample 56 percent of the documents that workers were required to understand were above their level of comprehension. Thiel (1985) found that 30 percent of secretaries had difficulty reading at the levels required by their jobs, and 50 percent of the managers and supervisors were unable to write paragraphs free of mechanical error. It is obvious that communication does not always function as anticipated. As an example, the following text is cited as a warning in *The Technical Writer's Handbook* by Young (1989: 206):

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

Esoteric and impenetrable jargon like this is most likely to be perceived as *incomprehensible* by the uninitiated. Since readers who do not know the code are left out, its use poses the risk of “one-way only” communication, and has no value outside of initiated circles. In an experiment, Kirkman (1992) allowed a group of people to rate six different versions of four technical and scientific texts. In terms of content, the texts were equal, but they varied in style of language. Three thousand people took part in the experiment. In the case of all four texts, the test group rated the versions that were written in an active, direct, and personal style as being the most easy to read and understand. Contrarily, the versions written in a passive, indirect, and neutral style, with complicated sentence structure, were judged by the test group as being the most difficult to read and understand. It seems as arcane, abstruse texts have become a global problem in technical as well as in scientific documentation. Kirkman (1992) opens the first chapter of his book *Good Style* with the following two paragraphs (p. 2):

It is surely axiomatic that the aim of technical writing is to transmit information accurately, quickly and economically from one person to another. Then why do so many scientists and engineers make their writing so heavily unreadable? Obviously, their subject matter is sometimes complex and conceptually difficult; but frequently the ‘unreadability’ stems from the use of a style that makes the reader’s task much heavier than it need be.

Good documentation implies *very good comprehensibility* and low cost, as well as ready accessibility when it is needed, and only then in fact. Poor comprehensibility diminishes the receiver’s confidence in the sender of the documentation, and heightens the risk of unsound decisions. Many good suggestions may be rejected because the people who determine their practical merit simply do not understand what the suggestions call for.

Because technical and scientific 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. Melin (1992) noted that comprehensibility in a text depends on perspective, abstraction, context, complexity, and redundancy. These qualities are themselves difficult to describe; small wonder, then, that the comprehensibility of text defies assessment. A message is comprehensible if it can be grasped by the receiver without difficulty.

Drew and Grimes (1985) found that background or adjunct information is needed to fully understand any text. Explanatory information that is easily reachable places a text within a realm of understanding, as opposed to information with-

out any additional easily accessible references. According to Brown and Bookman (1997) all documents face the following challenges:

- Does the audience truly know the meaning of all terminology used in any specific field?
- Does everyone reading the documents have precisely the same command of English?
- How quickly can students, users, and readers assimilate and then actually use the information they are given?
- Does all of the publication's intended audience have the same background, or do some people need a little brushing up before they see the whole picture?
- Does the learning process need to be accelerated for employees, readers, or students?
- How certain is it that everyone a document reaches truly understands that document in the same way?

Speaking and writing are language-related activities performed by the sender. These activities are influenced by the sender's earlier observations, and by the terminology and the language he or she uses. Besides being active, the sender is in charge of encoding the message, that is, its production and distribution. Listening and reading are language-related activities performed by the receiver. As is the case with the sender, the receiver's activities are influenced by earlier observations, as well as by the terminology and the language he or she uses. Besides being relatively passive, the receiver is in charge of accepting and decoding the message.

The readability, legibility, and reading value of the graphic message are of decisive importance to the receiver's ability to understand it. Moreover, these factors – besides being influenced by the writing process – are all prerequisites for the reading process. The reading value of a message is the receiver's subjective evaluation of the contents of the text and pictures. What is interesting to one person can be deemed dull by another. We must therefore adapt text and pictures to be palatable to any given target group. Reading value in the written word is comparable to listening value in the spoken word.

2.4.1 Text structures

Waller (1987) pointed out that the writer's text is different from the reader's text. In traditional systems for book-publishing, the writer deals with a document that becomes progressively more formal as production processes develop: rough notes become typescript, typescript become galleys, galleys become pages, pages become chapters, and chapters become a book. Traditional printing methods require the writer to make most significant decisions in relation to a manuscript and type

specification. The reader, on the other hand, sees only a finished product, which is expected to betray little of the complexity and the difficulties of the writing process. Usually printed texts vary a great deal from their original manuscripts with respect to letter-forms, line length, line endings, page breaks, page size, spelling, spacing, punctuation, etc., and even in the use of words. Often the printed text has illustrations. There may be drawings as well as photographs in the final product.

As desktop publishing systems have become more common, this situation has changed a great deal. In personal publishing the writer is responsible not only for the content of the text and pictures but also for the editing and the graphic design. The writer's text and the reader's text will be the same. The writer may very well know his or her own subject matter but will have to also learn at least some of the traditional skills of the editor and of the graphic designer. Communication is vastly more efficient and effective if it follows a plan instead of being a miscellaneous list of sentences or paragraphs. People remember more and read information more quickly when it is logically organized with a plan than they do when the same information is presented in a disorganized, random fashion. Text structure is important, even at the sentence level. Traditionally, most texts are presented in a linear or rather in an interrupted linear fashion. Thus, the writer exercises strong control over the reader's use of a document. The readers have few alternatives. They will basically have to accept the way the content is presented. Non-linear presentations represent much weaker control of the reading process from the writer. Examples of non-linear presentations are lists, tables, linear branching, matrixes, and, of course, all kinds of visuals. According to Jonassen (1982) the literature related to the design and organization of text can be divided into two large categories: (1) internal textual structuring and (2) external textual structuring.

Internal textual structuring 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 cuing, introductions, topic sentences, transitions, pointer words, and summaries.

External textual structuring refers to the techniques used to structure text with linguistic, spatial, and typographic cues. These techniques include the use of blocked text, horizontal lines to divide blocks, italicized text, and bold text.

2.4.2 Text indexes

To describe the properties of text, the linguists work with advanced text analysis. According to Klare (1985) over 200 readability formulas exist. Only three will be noted here: the *readability index*, the *character index*, and the *nominal quotient*. The number of words in a sentence appears to exert the strongest effect on reading

rate and reading comprehension (Catalano 1990; Newell 1990). The premise on which the readability and character indexes are based is that long words and long sentences make a text difficult to read. The readability index is the sum of two calculations: the percentage proportion of long words (consisting of – depending on the language in question – the number of letters or syllables in a given word) and the average number of words per sentence. However, the readability index, while usually corresponding quite well both to people's subjective experience of the readability of a text and to their actual results in comprehension tests, has received strong criticism. This is due to the fact that varied sentence length actually contributes to the ease of reading. The index of readability (LIX) is calculated as follows:

- Count the number of words in the text.
- Count the number of words with more than six letters.
- Count the number of sentences.
- Divide the number of long words by the total number of words and multiply the product by 100. This yields the average word length (WL).
- Divide the number of words by the number of sentences. This yields the average sentence length (SL).
- $WL + SL = LIX$.

20–30 = simple text, suitable for children's books

30–35 = literature

35–45 = moderately difficult text, weekly magazines

45–50 = popular science subjects

50–55 = difficult text, trade literature

55+ = extremely difficult text

The *character index* can be looked on as a visualisation of the readability index. Each sentence is analysed and noted on a chart depicting a system of coordinates, in which the y-axis represents the number of long words and the x-axis the number of words per sentence. Thus, by graphically providing more than a single mean, the character index offers more thorough information about a text than the readability index. The *nominal quotient* gives the total number of nouns, prepositions, and participles divided by the total number of pronouns, verbs, and adverbs in the text. A good information text has a quotient of slightly more than one. A text with a lower nominal quotient seems “chatty”, whereas a text with a higher nominal quotient is cumbersome and hard to read.

Research into readability has been directed towards finding the characteristics that make texts easy or difficult to understand. However, Gunnarsson (1982) pointed out that the psychological equivalent to *readability* is merely superficial understanding. Therefore, she prefers to use *comprehensibility* as the term for char-

acteristics that are related to deeper, specific text understanding. Gunnarsson's theory of comprehensibility is based partly on the correlation between the level of understanding and the level of the text, and partly on the premise that what is read influences the reading process. The text should also be *well worth reading*. This designates the properties of the content of a text and is very dependent on the reader's degree of interest. Each group of readers selects reading material on the basis of personal preference. Cotton (1995a) noted six barriers to understanding of a verbal message. These barriers are:

1. You may not know the meaning of the word which is being used.
2. There can be different meanings of the same word.
3. There can be a misunderstanding of English grammar.
4. There can be a misunderstanding because of context.
5. Sometimes you do not understand the inference.
6. Personal but erroneous explanations.

In the USA, there is an increasing incidence of law suits being brought against manufacturers. 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 readable and legible*. 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.

2.4.3 Terminology work

The study of terminology encompasses terms, concepts, idioms, definitions, references, conceptual systems and semantics (Figure 2.3). A *term*, or a *technical expression*, is a word or expression for a particular concept found in a given field of work, in which it has a specific and carefully determined meaning. A term can be regarded as a "label" and need not be exhaustively explanatory. A *concept* is an idea of something formed by mentally combining all its characteristics or particulars, a mental notion of a group of referents. For the concepts to be represented verbally and in writing, they must be given linguistic expressions: denominative and descriptive. 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 *definition* is a linguistic description of a concept. The definition may normally replace the term in a text. A definition must not contain words like "often" and "sometimes". A *referent* is an object, abstract or concrete, for which a name

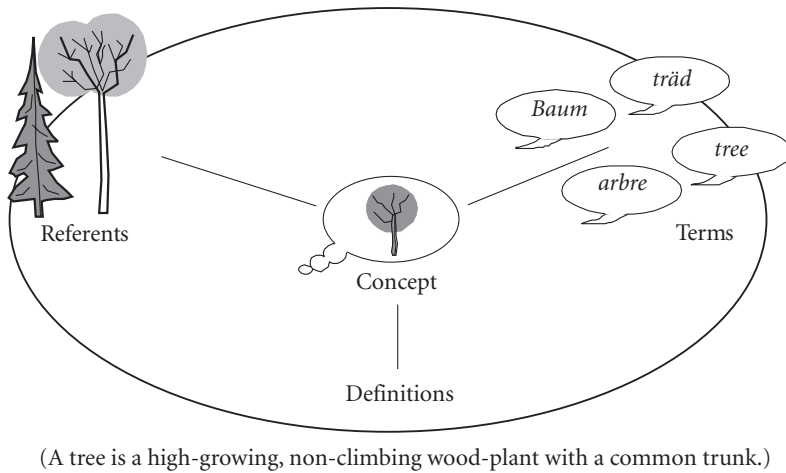


Figure 2.3 Connection model. The Swedish Centre for Technical Terminology (TNC) describes the connection between concept, terms, definitions, and referents, in accordance with the model above.

or designation stands and to which a specific concept refers. A *conceptual model* is a systematic description of the relationships between concepts in a subject field, a particular area of thought. Conceptual models, which may be partitive, generic, or associative, 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.

To make information exchange efficient, all staff in any major R&D project must use terms and concepts that are not misunderstood. Research and development is generating a never-ceasing flow of new terms and concepts. In pioneering technologies, clear-cut definitions and descriptions of concepts, processes, products, and services are particularly important. Simultaneous development in different parts of the world involves the risk of similar terms being used with different meanings, or – vice versa – dissimilar concepts being given identical terms. As a result, coordination in some form or other is needed.

Terminology work involves continuous collection, review, and presentation of new terms and concepts. These terms should be made available as printed or electronic documents in order to be used in the daily work. Concepts and terms are created by individual staff members or groups of staff. This means that there will be a number of “originators” of preliminary or working terms, and the corresponding definitions. The people who create concepts and terms may be called “originators of terms”. They should get into contact with the terminology coordi-

nators, who continuously collect new terms and concepts related to their field of activities, and compile their department or project glossaries.

The terminology coordinators may organise one or more – temporary or permanent – terminology committees. Concepts and terms of importance to several staff members in the group may be discussed in these committees, which may occasionally include a representative of the terminology administration, with a chairperson and a secretary, should maintain contact with the terminology coordinators and they convene the terminology council. The council may discuss problems of common interest and make the necessary decisions.

The terminology administration's tasks may also include successively making a list of terms from those compiled by the terminology coordinators. Tangible results of terminology work may be a *glossary* and an *encyclopedia*. A glossary contains brief explanations of terms. An encyclopedia describes terms in more detail and includes symbols, illustrations, and conceptual models. The glossary and the encyclopedia may be stored in a common database in order to be accessed by all staff. The definition of individual concept's superordinate, subordinate, and collateral relationships is an important part of the terminology work.

An *associative concept system* shows relations, that is, functional relations, between different concepts. A *partitive concept system* shows the different parts that together form a superordinate concept. A *generic concept system* shows different types of hierarchical concepts. The same concept can be included in the different types of conceptual systems. The word *perspective* usually refers to a reproduction, on a plane surface, of a three-dimensional object, which conveys to the human eye the same impression of depth as that of the real object. Obviously, it is a matter of creating an illusion of depth; on a paper surface, for example. Different types of perspectives are listed below in alphabetical order:

- *Aerial perspective* is a phenomenon related to the clearness of the atmosphere. Objects viewed from a long distance are indistinct because the air is filled with a grey or greyish blue haze, which makes distant objects seem wrapped in mist and partly hidden.
- A *bird's-eye view* means that an object is viewed from a high position.
- In a *central perspective*, lines in the picture converge at a common point of intersection even though they are parallel in reality.
- In a *colour perspective*, colours and hues gradually change. They are clear in the foreground and blurred in the background.
- *Content perspective* is the same as perspective based on meaning.
- The *cropping perspective* – certain objects placed in front of others – is used to enhance the impression of depth in a picture.
- During the Baroque era, perspective was used in pictorial art and architecture for the purpose of creating illusionistic effects, or *imaginary perspectives*.

- In a *line perspective*, objects are conceived as being placed behind a picture plane onto which straight beams of light are projected.
- In art of more ancient date, and even in primitive art, there are many examples of perspective based on *meaning*, *contents*, and *value*. The significance, rank, status, or value of depicted objects is evident from the objects' size in the picture.
- In a *parallel perspective*, the distance is endless, and parallel lines of an object are parallel in the picture too.
- *Positional perspective* is based on the fact that objects seem smaller and less distinct the further they are from the viewer.
- In a *reversed line perspective*, the foreground seems to be “smaller” than the background. The straight lines converge in the direction of the viewer. This perspective is frequent in Japanese and Chinese art.
- In a *shadow perspective*, projected shadows are sharply accentuated, as a means of displaying the location of different objects and their spatial relations to each other.
- In the medieval *simultaneous perspective*, time is a spatial dimension.
- *Value perspective* is the same as perspective based on meaning.
- Used figuratively and in transferred senses: *verbal-linguistic perspectives*. In a situational context, for example, we may say that someone “sees reality from a child's perspective”.
- A *worm's-eye view* of an object means that it is viewed from below.

Obviously, some of the perspectives I have mentioned are related to each other in various ways. When we group the different meanings systematically, it becomes evident that a number of concepts are missing. Undeniably, it is easier to survey the interrelationships between concepts when they are systematically arranged. As is evident from the hierarchy below, most perspectives are *pictorial spatial perspectives* related to our perception of depth.

Perspectives

Pictorial perspectives

Spatial perspectives

Realistic linear perspectives

One-point perspective

Two-point perspective

Bird's-eye perspective

Military perspective

Gentleman's perspective

Eye-level perspective

Worm's-eye perspective

Parallel perspective
Reversed linear perspective
Intuitive perspectives
 Overlapping perspective
 Aerial perspective
 Tonal perspective
 Colour perspective
 Geometrical perspective
Conceptual perspectives
 Multi-view perspective
 Value perspective
 Simultaneous perspective
 Imaginary perspective
 Time perspective
Verbal-linguistic perspectives
Aural perspectives

However, the term “perspective” also carries other meanings, not related to depth and depth perception:

- *Conceptual perspectives* are visualisations of psychological and social, subjective values.
- *Verbal-linguistic perspectives* are used figuratively and in transferred senses.
- An *aural perspective* is an apparent spatial distribution in perceived sounds.

2.5 Oral presentations

We can speak because we have a specially constructed vocal apparatus with which to make appropriate sounds, and because we also have areas of the cortex of the left hemisphere in the brain that are dedicated to producing language. Broca’s area, an anterior zone in the left frontal cortex, is thought to articulate speech. A posterior zone called Wernicke’s area is thought to be the repository for the ideas to be articulated. The two areas are connected so that this expression of ideas through speech can take place. An essential difference between the spoken and the written message is the time available for transmitting them. The production of speech must take place in the here and now the speaker and his or her listener communicate in real time. On the other hand, the writer and his or her reader can take the time they need.

Usually we understand what we are saying. We know what we mean. However, we can never be sure that other people perceive our verbal messages as we have intended. On the contrary, people perceive and depict a given message in widely dif-

fering ways (Pettersson 1986). Many animal species are capable of communicating with the aid of sounds. The messages they convey often express simple concepts, such as hunger or repletion. These acoustic messages are usually sent to individual(s) of the same species. However, the noisy cries emitted by a crow to “warn” the flock are actually a form of “mass communication” rather than personal messages.

One of the simplest forms of communication between humans, the crying of an infant, is to some degree specific for that special individual. Parents often quickly learn how to understand the meaning of some different kinds of acoustically similar crying. They can also distinguish their own child’s crying from the crying of other infants. After some time the child acquires linguistic facility, enabling it to express a wide range of needs and emotions. More than 2,000 languages and countless dialects have long been said to exist. However, Gunnemark and Kenrick (1985) claim that there are probably 5,200 living languages, certainly no less than 4,500 and possibly as many as 6,000. Tens of thousands of years ago, our ancestors were able to communicate with one another by means of some linguistic expressions. Over the millennia, language ultimately evolved into Man’s most important means of expression.

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. Concepts probably form in their brains in a similar way as in Man’s brain. Several scientists in the U.S. and in Japan have succeeded in teaching chimpanzees to communicate by means of visual sign language. Chimpanzees can deal with more than 100 words and display linguistic creativity, i.e., they are independently able to form new, logical word combinations. To a certain extent, their language has a grammatical structure. Previous attempts to teach apes to learn a language probably failed because they involved efforts to teach apes to speak, despite their anatomical inability to produce human language sounds. Even very primitive societies often have advanced languages providing scope for great expressiveness. These languages sometimes contain many subtle terms for concrete concepts.

A pioneer in the field of semiotics, Ferdinand Saussure, divided the phonologic components of language into their smallest, non-meaningful parts, i.e., phonemes. Phonemes are basic units of sound. When combined, they form units with meaning. A language’s smallest meaningful grammatical unit is referred to as a morpheme. Morphemes are combined to form syntagms (Fredriksson 1979), i.e., words, phrases, sentences, and complete texts. Spoken and written languages are formed from a limited number of phonemes (usually 20–40). These phonemes can be inter-combined in a limited number of ways. We can make a distinction between individual language, i.e., speech, and super-individual language, i.e., the language itself. When we speak and write, the phonemes, morphemes, and syn-

tagms we use must follow one another in a particular sequence if our messages are to be understood. Language is consequently hierarchic and linear.

The term “spoken language” is almost always taken to mean direct, informal verbal language. A sender and a receiver share a highly interactive communication situation. This situation offers immediate feedback and opportunities for explanations and corrections. However, the situation is highly transient and impossible to rehear/resee. On the other hand, the spoken word in technical media lacks any interactive component to facilitate communications. TV, though, does have limited, sender-controlled or simulated interaction. These media all lack immediate feedback but are non-transient, at least in principle, and their messages can be played back. Speech conveyed by technical devices depends on the quality of the reproduction technology employed and even on factors such as cost. Speech reproduction devices often clip higher frequencies, thereby impairing reception conditions for the listener and conveying speech less adequately than direct conversation. This all means that the reception conditions of the spoken word conveyed by technical media are similar to the reception conditions of the printed word. The sender must plan her/his message carefully. She/he must practice cognitive clarity and avoid ambiguity – both acoustically and optically. As is the case for the printed word, the language used by broadcast media for recurrent messages, such as weather forecasts, can be rationalized and formalized.

Dahlstedt (1979) predicted that the verbal language used in media would not only develop on its own terms but even exert an impact on the spoken language as a whole. The media probably do have a levelling effect on the spoken language and thereby contribute to the disappearance of dialects. As a result of its wide-ranging coverage, the language of broadcast media tends to become a national standard to a greater extent than direct conversation. As is the case for the written language, the language of broadcast media is tailored to be understood by a wide range of listeners/viewers with widely varying backgrounds. This development is bound to retard new language development, since the use by message senders of old and familiar phraseology maximizes the likelihood of message comprehension by receivers.

2.5.1 Assessments of speakers

Assessments of oral presentations with focus on the speakers (Griffin 1990), and on the listeners (Pettersson 1992) showed many differences in their opinions. Many listeners have a feeling that presentations last (too) long. Speakers, however, quite often declare that they need much more time to explain what they want to say. It is possible that speakers underestimate, and listeners overestimate the average length of a presentation. Speakers express that they often use visual support

when they make their presentations, more than a third of them answered “always”. However, less than one-tenth of the listeners gave the same answer. Presenters have a tendency to overestimate their own use of visuals. Overhead transparencies were the most frequent visual medium, followed by slides.

Speakers who use slides in a presentation tend to use more visuals than speakers who use overhead transparencies. Most visuals were prepared by the speakers or by their office staffs. The most common purpose of the presentations was “to inform”. By far the most common type of content was *word visuals*, predominantly lists of words. Word visuals were followed by *diagrams*, visual representations of flow, direction, or procedure to be followed in the completion of a process, and *graphs*, numerical arrays in pictorial form.

On average, photographs were not used as often. With respect to the average quality of execution of visuals used in presentations, about a third were considered good or very good, and roughly two-thirds were judged not acceptable. With respect to the average quality of the actual presentation (AV showmanship), about a fourth of all the presentations were considered good or very good. However, three out of four presentations were judged not acceptable. It is obvious that speakers often are aware of the poor quality of their visuals. Comments such as the following are not at all unusual in presentations:

- “I know that you can not read this text”
- “Unfortunately you may not be able to see this”
- “I will read the text for you, since it is too small/blurred/in-distinct.”
- “You do not have to read this”
- “The copying machine is in poor condition”
- “Please excuse my handwriting”

It is, however, more and more common that speakers just ignore the poor quality of their visual materials. It may be concluded that a widespread use of visuals in oral presentations is evident, as is the need to improve the quality of such presentations in a variety of dimensions.

2.5.2 Speech and body language

The speaker must constantly strive to maintain close contact with individual listeners in order to ensure that the information is reaching the mark and being understood. Listeners cannot back up and review oral information in the same way that they can with printed information. So every presentation should commence with an overview of the content to be discussed and conclude with a summary of the content. This will enable listeners to obtain the best possible grasp of the total message. Including time for questions is also often appropriate.

Speakers transmit visual impressions. For students, teachers constitute “living pictures”. This is because speakers employ body language in addition to oral language. Continuous contact between teacher and students can be sustained solely with the “speech” of body language. Body language reflects a person’s emotional state, attitudes, and personality. It discloses whether a speaker is happy, pleased, angry, annoyed, confident, uncertain, truthful, or lying. Children, and even adults, are often highly sensitive to messages conveyed with body language. So a speaker’s glances, gestures, mimicry, posture, arm and leg movements, and presentation method can serve to reject or confirm her/his oral message. Some experts claim that body language is often more important than the words in an oral presentation. Ringom (1988) wrote as follows (p. 29, in translation):

Most of the research reports I have studied indicate that words only account for about 10%, intonation about 17%, and body language (i.e., mimicry, eye, ear, and leg movements, and posture) about 73% in a communications process.

Body language is both instinctive and something we mimic and learn. A given gesture often means different things in different cultures. We convey facts with words but emotions and values with our bodies. So people are usually unable to “lie” with their body language. We listen more emotionally than intellectually. Keller and Burkman (1993) noted that the enthusiasm of an instructor or speaker can stimulate positive motivation among students. A sensitive speaker can learn to use her/his gestures, movements, facial expressions, and articulation for punctuating, underlining, clarifying, and enhancing the vitality of her/his words. The choice of clothing can also convey fairly detailed information. This is especially the case for markers and symbols associated with particular groups of people.

A speaker must always be easily visible. So a speaker should avoid being hidden behind a rostrum so only her/his face and part of the trunk are visible. The ability of a speaker to move freely in front of her/his audience is also an advantage. A speaker must be able to see listeners in order to maintain contact with them. So making an effective presentation in a dark room in which the speaker is standing in a spotlight is extremely difficult.

Exemplification of an oral presentation with demonstrations using relevant objects or events is almost always beneficial to audience comprehension of a speaker’s message. Demonstrations can arouse the audience’s interest, reinforce message perception, and improve audience ability to comprehend a message. Giving the audience a chance to examine and touch an object or experiment with and influence a course of events is even better. The playback of brief, authentic sound illustrations can easily enhance a sense of reality or create a particular mood.

2.5.3 Speech with pictures

A speaker unable to exemplify her or his message with real objects should employ visuals instead. Stills can be used to supply structure and an overview, provide concrete examples, approach reality more closely, show what something really looks like, create interest, reinforce a message, or summarize a presentation. We should use visuals as actively as possible. People remember things they've seen more readily than things they've heard. Speakers should describe, explain, and ask questions about visuals. It is not enough just to show the pictures in a rapid pace without any comments.

Stills can comprise text, tables, graphics, maps, different kinds of diagrams, and, naturally, drawings and photographs. We should avoid visuals containing excessive detail. Do not use visuals needlessly! The visuals used should be relevant to the context and make a genuine contribution. They should also be easily grasped. In an oral presentation, listeners have few opportunities for detailed study of a visual at a comfortable pace. The visual is usually displayed at a considerable distance and at a point in time selected by the speaker. So a visual employed in an oral presentation should be designed differently than a printed picture in a book. In oral presentations, each visual should only depict a single object, idea, or trend. Multiple visuals should only be displayed simultaneously in direct comparisons, e.g., of different objects or events. When a series of pictures is used, it is important for the subjects to be depicted on the same scale to prevent viewer confusion.

Wileman (1993) showed a way to organize the relationship of verbal and visual images along a continuum, the verbal/visual continuum, or the degrees of visualization. The continuum is represented by seven types of visuals, ranging from purely verbal to purely visual. The seven types are Reader Frame, Emphasized Reader Frame, Reader Frame with Visual Cues to Meaning, Verbal/Visual Balanced Frame, Pictorial or Graphic Symbol Frame with Verbal Cues to Meaning, and Pictorial or Graphic Symbol Frame (pure visual).

Whenever visuals are displayed, the speaker always runs the risk of losing contact with the audience. Suggestive visuals can easily create a number of associations that deflect the audience's thoughts away from the subject of the presentation. However, the speaker can pave the way for improved audience comprehension of a subsequent visual by disclosing in advance what the visual depicts. The audience will then find it easier to identify important picture content and select a relevant interpretation. When a picture is shown, viewers need some time to interpret and understand its contents. The speaker must never be positioned so she/he blocks the audience's view of a visual. It is always important that projectors are placed in stable positions. Small movements of the projector will cause large "jumps" of the projected image.



Figure 2.4 Many speakers talk to the projected image and not to the audience. This is far to common.

2.5.3.1 Overhead transparencies and slides

Overhead (OH) transparencies can only be projected with an overhead projector, and room illumination (at least illumination near the screen) must be reduced (Figure 2.4). To prevent image distortion, the top of the screen must usually be tilted forward. The projector should be put at such a distance from the display screen that the complete image is projected on the screen. If parts of the image fall on the wall, outside the screen, this may be quite disturbing. It is also very important that the whole image is in focus. Dirt on the transparency, on the lenses, or on the screen is also disturbing and makes the real image less effective.

The overhead projector should only be on while projecting a transparency. A visual should not be displayed any longer than it takes to explain its contents. A composite overhead can be formed with a basic transparency and add-on transparencies prepared in advance. However, successively exposing parts of a transparency by removing, e.g., obscuring pieces of paper, is usually unsatisfactory (although a common practice, even by many visual experts). Adult viewers could be distracted by the picture's dark areas and begin wondering about the hidden information instead of giving their full attention to the presentation.

Many speakers use text transparencies, or “word-visuals”, containing key words in attempting to supply an overview, clarify, reinforce, and summarize com-

plicated arguments. These texts must then be brief and concise. They must also be easy to read. For good legibility, characters should be large, distinct, and boldface, never less than 5–6 mm high when projected in a room the size of a normal classroom. Larger rooms require larger character sizes. Normal text, containing both upper-case and lower-case letters, is easier to read than texts using only upper-case letters. Overhead transparency texts should usually consist of black characters on a light background. Text images are a useful adjunct for a speaker but are sometimes very boring to an audience.

It is not enough that a slide be well-designed and have a high technical quality. It should also be projected and used in a correct way. A room must be properly darkened for the most advantageous projection of mounted slides and filmstrips, unless equipment is available for back projection, i.e., projection from the rear onto a matte-glass screen. A slide's subject should appear against a black background. Text slides should only be used to a limited degree. Texts should be light (white or yellow) on a dark background (e.g., black or dark blue). Many colour combinations are hard or even impossible to read. Basically the same is true for data- and videoprojectors and computer aided presentations.

2.5.3.2 *Wall charts and other pictures*

Wall charts, mounted photographs, some posters, picture collages, wall maps, and roller blind-type maps are usually good teaching aids, provided they are relevant and large enough. These visuals can be mounted on a wall or, for small groups, placed on a table. Only use one visual at a time unless different visuals are to be compared. Remove any unneeded visuals so they do not distract the audience. Using a flannel board and flannel board visuals always demands preparations. But this presentation form can be rather effective, especially when the audience consists of children. An episcope, i.e., a device capable of projecting opaque originals, such as text and visuals on paper, or small objects, is used sometimes, although not very often any more. The episcope can be used for projecting any kind of text or visual, such as material printed in books and newspapers. There is then no need for special overhead transparencies or slides. A room must be very dark for effective projection of episcope images. Speakers can write or make simple drawings on a conventional blackboard (although not often black any more) or a more modern version, the flip-chart, in a small locale with full room lighting. Complex drawings should be prepared in advance of the oral presentation.

As a rule, the contents of films and television programs are presented in a pre-ordained fashion, which tends to encourage relative passivity in viewers. The same is true of prepared oral presentations. The reader of a book digests textual and pictorial information at his own pace. If the information presented in the book has a structured surface, i.e., one in which the information is integrated into a single

context, the reader can focus his attention relatively freely. The experience is akin to the way we take in information in real-life situations. Interactive video programs make it possible to combine sound and moving pictures thus, they can arouse considerable activity and commitment in the user. Since an interactive video program can stimulate the user to perform at a high cognitive level, it has the potential to function well, both as a conveyor of information and as a teaching aid.

Events that are hard to illustrate with stills and difficult or hazardous experiments can be depicted with the aid of moving pictures, i.e., film, video, computer animation, or TV. A brief example only lasting a minute or two may suffice. Video is an excellent aid. A speaker can conveniently introduce the appropriate moving sequence at exactly the moment when it has the maximum impact. Sequences can also be repeated one or more times if necessary. Information in pre-recorded presentations, like films, is conveyed by various combinations of different audio-visual presentations, i.e., words and text, audio illustrations and sound effects, stills and moving images in colour or black and white. All “traditional” information and teaching programs can be used in a “linear” way. Programs can be distributed as film prints, video cassettes, or video discs in various formats. Programs can also be distributed as broadcast TV programs or as satellite and/or cable TV transmissions.

2.6 Writing

We write information and learning materials in order to be read. The basis for writing is to consider the reader and his or her actual situation. We need to define the purpose of any text, to define who the reader is, and how we want him or her to change after having read the text. A good starting-point is to consider what the reader may misunderstand in what we are about to write, and actively prevent these possibilities for misinterpretations and misunderstandings. The more complicated a subject matter is, the more important it is that we make the text comprehensible and manageable for our selected group of readers. This means that we have to work a lot with the structure, the linguistic usage, and the writing style. It may be a good help to have a clear writing strategy. However, before we begin writing we need to consider some aspects of writing.

2.6.1 To begin with

The physical act of writing down one's thoughts with the help of a pen or a keyboard may not require much time. It often takes longer to think of what the text should consist of than to formulate it. The writing process encompasses much

more than merely writing, and it is relatively independent of the language used. Before we begin our writing, we need to identify the subject matter and define the purpose of the message. This requires analysis of the target group or the receivers. A receiver analysis might contain evaluation of the receivers' basic understanding of the subject matter, their trade knowledge, experiences, skills, comprehensive capacity, attitudes, prejudices, motivation, linguistic competence, social background and vocation, as well as their age and the various groups that they may belong to or identify with.

Because all of these factors influence how the receiver understands a message, they are decisive for text formulation. We need to gather and sort our material, as well as plan and outline our presentation. We need to choose the typeface, graphical form and medium. It may be possible to use fixed writing patterns, established models and templates. When we have formulated the text, we will need to process it and adapt it, so that it will suit our readers. Writing in information design is functional, and differ from creative writing in the same way as graphic design differs from fine arts. We may have to rewrite the text many times before it is finally right. Although it may be true that even the most complicated texts can be presented in a comprehensible form, all writers need practice, practice, and still more practice. A number of authors offer hints on how to write effective texts. Rowntree (1966) offered twelve guidelines:

1. Write as you talk.
2. Use the first person.
3. Use contractions.
4. Talk directly to the reader.
5. Write about people, things and facts.
6. Use active verbs and personal subjects.
7. Use verbs rather than nouns and adjectives.
8. Use short sentences.
9. Use short paragraphs.
10. Use rhetorical questions.
11. Dramatize whenever possible.
12. Use illustrations, examples, case studies.

Liljestrand and Arwidsson (1979: 15) asserted the following (in translation):

Complicated texts are often defended on the grounds that their subject matter is complicated. In reality, however, the more difficult the subject is, the more one must attempt to express it in a comprehensible way. It is surely more reasonable to expect that someone who is writing for several people expend effort on the writing of his text, than that the various receivers be obliged, each on his own, to expend effort interpreting it!

Also Strömquist (1991:35) maintained that everyone must practice writing to become good at it. Writing is a skill that we can learn. She wrote the following (in translation):

It is only by writing oneself that one can fully understand the complicated writing process; it is only by writing oneself that one discovers where the problem lies.

Bergquist (1991) gave textbook authors five terse, vigorous instructions in the form of “commandments” (in translation):

1. The first commandment: *Don't write!* Even if the author's first impulse is to start to write at once, it is essential to begin with an outline.
2. The second commandment: *Use pictures!* Get a picture to illustrate each section; wait with your text.
3. The third commandment: *Write captions for each picture!* Each picture should have a relevant text, which may even have a heading.
4. The fourth commandment: *Talk to your editor!* Together, the writer and the editor can expand a factual outline into a detailed outline for each layout. The outline contains room for both text and pictures.
5. The fifth commandment: *Write in a structured manner!* The text should complement the pictures. Therefore, write in the space between the pictures. The editor provides the author with exact data about the number of strokes each line of text may fill.

2.6.2 Writing strategy

In the following sections, there are some suggestions on a *good writing strategy as the key to good comprehensibility* of information materials. Unlike rules of grammar, these suggestions will change as new research conclusions supplant the old knowledge base. To avoid distracting the readers, the *linguistic usage* as well as the *style* should be correct. There are several good books available for British as well as American English. See *The Publication Manual of the American Psychological Association* (1996); and also Kirkman (1992, 1993); Klare (1985), Strunk and White (1979), *The Economist* (1991), and Young (1989).

2.6.2.1 Analysis

- Define the purpose of the intended message.
- Define the receiver of the intended message.
- Define the type of representation. What will be needed?
- What characteristics do the readers have? Note important facts.
- Are the readers positively or negatively disposed to your message? What are their expectations?

- What external factors can influence how the readers will interpret your message?
- What financial conditions or limitations apply?

2.6.2.2 *Preparation*

- When you create a message, proceed from what you know about the readers. What are the readers' levels of knowledge?
- Make a preliminary writing plan. Allot sufficient time. Preliminary planning may take up the bulk of a writer's time.
- Study the subject matter by reading, interviewing experts, making observations, and performing experiments.
- Sort out the material that will be included with your text. Proceed from what you know about the readers' potential for understanding it. Focus on the most important aspects.
- Structure the material. This is more important than the actual writing. Make an outline of your subject matter; you can refine it and go into details later on. A report should have a title, a table of contents, an abstract or summary, an introduction, a description and an analysis, a conclusion, and a list of sources or references. Avoid footnotes and appendices, since they are seldom read.
- Plan for illustrations.
- There are different types of outlines, for example, narrative and logical outlines. Use few types in the same document.
- Start with the known; proceed to the unknown.
- Write brief and interesting titles and headings.
- When necessary, provide the text with a document number, a security classification, date and other administrative information.
- Choose a graphical form that suits the material and the selected medium. A well-thought-out graphical form contributes to the readers' understanding.
- Plan for reviews. Documentation that is not technically correct must not be used as learning support or course material. The documentation must be re-edited until it receives approval.

2.6.2.3 *Writing text*

- Let your writing be simple, clear, and concise. Express yourself in specific rather than unspecific terms. Use a consistent terminology.
- Use a style that is natural for you. Avoid colloquial language, excessively formal constructions, sexism and stereotyping.
- Analyse, argue, describe, compare, refer, make associations, all according to what you think is needed.

- Try not to insinuate subjective values into your text. If it is your own opinion you are expressing, make this clear.
- Avoid writing in a style that is too laconic or sterile, but do not allow yourself to become “chatty”. Sentences that are too dense, that is, sentences in which too many ideas are concentrated and presented, will make your text a tedious reading.
- Use aids, such as dictionaries and encyclopedias.

2.6.2.3.1 *The entire piece*

- There should be a theme running through the text. Try to find a unifying principle. Clearly show what you want to express.
- If the subject is on a high plane of abstraction, use concrete examples that illustrate the principles.
- You may use similes and metaphors. They make it possible for readers to create an inner picture.
- If the text shows a high degree of specification and examines several separate details, you should summarise every now and then and draw the possible conclusions.
- Sometimes you may find it necessary to write your foreword, introduction, and summary after the body of the piece is written.
- List your references clearly.

2.6.2.3.2 *Paragraphs*

- Let every paragraph encompass a single unit of content. Avoid long, convoluted paragraphs that meander in all directions.
- Link sentences and paragraphs with conjunctions and/or adverbs (*and, nevertheless, moreover, because, but, however, therefore, although, because, since, or, even, thus*), making sure at the same time that the things linked together bear a logical relationship to each other.

2.6.2.3.3 *Lists*

- Three or fewer simple items can be listed within a sentence.
- Four or more items are best presented as a bullet list, a numbered list or a hyphen list.
- As few as two (complex) items can be presented in a list.
- A single item should never be presented in a list.
- Each item in a list must have the same general form and use the same syntax.

- Each item in a list must begin with a capital letter. If your list item is a complete sentence then it must also end with a full stop. Do not use commas or full stops at the end of list items that are not complete sentences.
- Use a bullet list, or a hyphen list, when the information you are itemising does not have to be considered in a particular sequence.
- If the information you are presenting does have a particular sequence or a priority order, then use a numbered list. If possible, avoid using sub-levels within your list. Sometimes, however, it is necessary to use a secondary list within a primary list.
 - A secondary list starts with a hyphen.
 - There must be at least two items in a secondary list.

2.6.2.3.4 *Sentences*

- Sentences should say one thing at a time. Do not cram them with ideas. In general, try to vary the length of your sentences to increase reading ease, but avoid sentences that are too short or too long.
- Simple, active, affirmative, and declarative sentences are the most readable. Be consistent throughout the document.
- Avoid complicated word order and subordinated clauses. Be careful in your placement of modifiers. Avoid the passive voice, write active sentences. Concentrate on verbs instead of nouns and gerunds.

2.6.2.3.5 *Words*

- Use short familiar words. Avoid long, polysyllabic, complicated words, buzzwords, slang, and expert jargon.
- Use defined and established terminology. Define abbreviations and acronyms in full the first time they appear in the text.

2.6.2.4 *Using pictures*

- Plan for the use of pictures. We can use pictures to make it easy for the reader to understand a message. Pictures and text must interact to produce unity. Place texts and pictures that belong together as close to each other as possible.
- Identify the sources of borrowed pictures.
- See Chapter 3 *Image design* for further information on pictures.

2.6.2.5 *Doing the touching-up*

- Let your text “rest” for a couple of days or so, then read it from the reader’s point of view. Make the necessary amendments.
- Check that the finished text corresponds to the planned text.

- Edit your text! Polish it. Trim away any unnecessary bulk. Iron out inconsistencies. Simplify the language. Clean up the punctuation. Every single sentence should be easy to read!
- Check the style and grammar. Discrepancies hinder the reader's progress and make the writer less credible in the reader's eyes.
- Check the spelling and word division at the end of lines. In some cases your word processing program can help you with this.
- Check references and other formal aspects of your text.
- Refine the typography and layout so that the headings, tables, and pictures are presented in a lucid, aesthetically pleasing graphical form. Make optimal use of the possibilities that typography offers.
- Make sure that text and pictures are reviewed before production and publishing. Use a consistent typographic style.
- Produce and distribute the text.
- Store the text for future use.

2.7 Credibility

Arvidson (1977, 1980) discussed early research on credibility with respect to mass media and defined four credibility concepts: (1) confidence, (2) credibility, (3) believability and (4) accuracy. According to Arvidson confidence and believability are properties of the public, while credibility and accuracy are properties of the mass media. Confidence, credibility, believability and accuracy are all important aspects of *persuasion*. Bettinghaus and Cody (1987) noted: "There are a number of early studies that clearly establish credibility as an important factor in persuasion" (p. 84). Sources possessing more credibility for a given audience are more effective in persuasion and are important for persuasion design. What makes a message credible? What does it mean that a message has high credibility? What does a high credibility message look like? What is the actual meaning with the concepts *credible* and *credibility*? Several contemporary dictionaries have different definitions of these terms. One of the three words *believe*, *believable* and *belief* are used in many of the definitions. It is obvious that in communication the receiver of a message believe in a sender with high credibility. However the sender, the message and the receiver may not be the only properties of the concept credibility.

In my view (1) the sender or the source, (2) the message, (3) the medium, and also (4) the specific context for the sender and for the representation may be important components or parts in the perception of credibility. These four components all influence each other and they also influence our overall notion or understanding of the concepts related to credibility.

2.7.1 Credibility of the sender

Fleming and Levie (1978) noted: “The credibility of a source is an attribution that is conferred upon the source by the receiver” (p. 199). Tedeschi and Rosenfeld (1980) stated: “Credibility refers to the truthfulness of the source over the occasions when his or her communication can be checked for accuracy” (p. 234). Bettinghaus and Cody (1987) defined credibility in this way, “Credibility is a set of perceptions about sources held by receivers” (p. 85). Thus, when we want to find out if a source is credible, we should ask potential receivers about their opinions on the matter. The source or the sender may be an “institution” such as a broadcasting company or a newspaper. The sender may also be an individual person.

According to Bettinghaus and Cody (1987), almost every study on source credibility seems to agree on the existence of both an expertise or a competence factor, and also a trustworthiness or a safety factor. There are various *levels of credibility*. At least we can distinguish between high and low levels. A source with a high degree of *trustworthiness* may be described with words like *agreeable, calm, congenial, ethical, fair, forgiving, friendly, gentle, honest, hospitable, just, kind, nice, patient, pleasant, sociable, unselfish, and warm*. The opposite words would describe a source with a low degree of trustworthiness.

A source with a high degree of *expertise* may be described with words like *able, accurate, authoritative, experienced, informed, intelligent, knowledgeable, skilful, and trained*. The opposite words would describe a source with a low degree of expertise. High-credibility sources exert a more persuasive influence on the receivers than low-credibility sources. In advertisements selected *experts* give their “expert opinions” on the quality of a specific product or a certain service. Linderholm (1997) argued that messages with logical arguments based on facts are useful tools when the goal is to change an attitude. Furthermore such messages may also increase the credibility of the sender. However, the sender must also provide evidence against an undesired attitude, otherwise the sender will lose credibility.

Hovland, Janis and Kelley (1953) stated that people who show high acceptance of a message from a high credibility source may show less acceptance later on, after a few weeks. They called this the *sleeper effect*. Through the 1950s and 1960s the sleeper effect had a firm place in the persuasion literature. However, later Cook and Flay (1978) demonstrated that the sleeper effect could not be reliably demonstrated without very specific conditions.

Ehrenborg (1984) declared that the *credibility of a speaker* is very much influenced by his or her actual performance in front of the live audience. Any message must always be in close agreement with the body language. A speaker that is lying will usually be exposed by his or her body language. An audience will believe what they see much more than what they hear. Thus it is also very important for the speaker to use slides, overhead transparencies and other visual support of high

quality. When a speaker uses visual aids of poor quality this will influence the receiver's perception of the credibility of the speaker. *The use of inferior overhead transparencies and slides may actually be devastating for the credibility of the speaker as well as the credibility of the message.*

2.7.2 Credibility of the medium

According to Becker, Martino, and Towers (1976) the credibility of a medium depends on a number of variables, including receiver characteristics such as age, gender and level of education. The National Swedish Psychological Defence Planning Committee has carried out comprehensive studies of the credibility of various media (Arvidsson 1977, 1980, 1981a, 1981b; Törnqvist 1974). At the end of the 1960s, television was superior in credibility, although by the beginning of the 1970s, radio was considered most credible. During the 1980s, radio and television were felt to be equal in credibility; fully 80% of those questioned were in accord with this. It does not seem as though all people in Sweden trust the information found in newspapers. In the autumn of 1981, slightly more than 10% judged the morning papers to be "most credible", while only 1–2% made that assessment of the information in the evening papers. It is primarily the younger generation who have the most faith in television. The older we are, the more credible we find the morning papers. Trust in the morning papers increases with our level of education.

Keller and Burkman (1993) noted that learners will be more motivated to learn if they believe in the truth and appropriateness of the materials presented to them. The credibility of an instructor or a set of course materials is influenced by several factors concerning the qualifications of the instructor, the reputation of the publisher, the quality and structure of the arguments in a message, and the correspondence of values and beliefs between the learners and the source of materials. Thus Keller and Burkman formulated the following *principle of motivation*: "Learner confidence and efforts to succeed are increased in proportion to the perceived credibility of the source" (p. 22). Keller and Burkman also noted that commercial producers have found that users' first impressions of a media product are very important to getting them to adopt (buy) it. Consequently, they spend a lot of time and money in giving their products a favourable feel or *image*.

Material with a (sufficiently) pleasing aesthetic form has greater potential for conveying a particular message than does an unaesthetic material. The sender's choice of graphical form will generate either positive or negative expectations in the receiver, while the choice of typography and layout can often give the reader a pre-understanding of the message's content. In other words, it is important that a visual message exhibit good legibility, or, if it is a spoken message, distinctness.

The message may be aesthetically pleasing, but in information design its content is usually more important than its form.

2.7.3 Credibility of the message

It is quite obvious that different specimens within a medium, such as individual newspapers, books, television programmes, movies, records etcetera will differ widely in their credibility depending on the contents of the various messages. Thus the credibility of the message is influenced by the credibility of the specific medium; and the credibility of the medium is influenced by the credibility of the message. The same message will be perceived in different ways in different representations. And the same kind of interactive influence can be seen between the representation and the sender. Fleming and Levie (1978) noted that: “The receiver’s evaluation of the message will affect the receiver’s evaluation of the source” (p. 203). Thus an effective message has to be both credible and to merit credibility. And Bettinghaus and Cody (1987: 100) stated:

What sources say is extremely important, but how they say it and how they behave while saying it does dramatically affect the receiver’s perceptions of the source, thus influencing the extent of attitude change the receiver is likely to experience.

What is typical for a message with high credibility? In my opinion it must be possible to understand the message and to be able to believe that the information is correct. The information can not be too divergent from the usual situations. Furthermore a high credibility message has a good structure, convincing arguments, proper references, and relevant examples. It is also a major advantage if text and pictures have good legibility as well as good readability. A picture used in information materials should depict reality in a manner appropriate to the content, and be as relevant and credible as possible. However, many pictures in textbooks and newspapers have been edited in order to change their importance and impact. The pictures can easily be enlarged or reduced in size, which will influence readability.

Still as well as moving photographic images are not always imprints of what actually was in front of the camera. Movie productions often use special effect scenes created with a blend of techniques. Digital manipulation of images has reached a point where it is often impossible to see what has been altered and what has not. Fetveit (1997) suggested that our trust in film images will be a product of institutional warrant rather than blind faith in the documentary power of photography. To some extent trust will pass from the photographic technology to the institutions and to the discourses where the images are used. When people view movies like *Jurassic Park* and *Independence Day* they are not likely to believe that these actually are true stories. Here the purpose is entertainment. The intention is not to present a representation of the “real world” but to present a representation of an

“imagined world”, a fantasy or a dream. In such a situation a manipulated image may employ high credibility.

2.7.4 Credibility of the context

Experiences in the *social context* will influence our individual selection processes, our mental processes, and our response processes. The influence of these factors have a major influence on how various receivers relate to verbo-visual messages of different kinds, and on how meaning is subsequently constructed. Photographers documenting the horrors of war have sometimes been rejected because their photos “can not be true”. And it is not possible for ordinary people to believe in them. The context in which a message is received will influence the credibility of the message as well as the medium and the sender, and vice versa. Within a medium credibility may be influenced by the *inner context*. For example, different placements of a message within a newspaper may influence the credibility of that specific message. For many people textbook authors are “high-credibility” sources. People believe in them. However, throughout history the use of pictures in various media has always been highly subjective.

Many readers and viewers may not understand that all pictures that are used in various media often have been subject to selection, sometimes several times. Evans (1978) noted that a sequence of photographs may add credibility to a central picture (p. 175). One way of “manipulating” and effecting the interpretation of image content is the careful writing of captions (Pettersson 1986). Views expressed in the captions regarding the messages in the pictures may vary from very negative to very positive. Thus the captions will influence what the readers actually select to “see”, or rather “interpret” from the contents in the images. Lidman and Lund (1972) claimed that a combination of a drawing and a photo will aid credibility. They wrote: “Through the drawing we understand the photo, through the photo we believe the drawing” (p. 30). Thus the drawing would influence our perception of the photo, and vice versa. This may very well be true in some situations.

It may be concluded that credibility is dependent on the perceptions of the receivers, and not necessarily on any actual characteristics of the senders or sources. People does not seem to realize that pictures seen in media are selected and edited, and only represent a “fragment” of reality. It is possible that people often believe that image content is “true”. The credibility of a picture is influenced by the credibility of the source, the message, the medium, and the specific context for the message.

CHAPTER 3

Image design

This chapter presents basic guidelines for visual production including a discussion of the graphical elements; dots, lines, areas, and volumes. Schematic pictures are usually made up of simple picture elements, such as, lines, circles, ovals, squares, and rectangles. These picture elements can be varied with regard to, for example, size, colour, and shading. Good image design is simple and direct.

In the design and production of visual information, we have to consider the characteristics of visual languages. We need to know how the illustrations will be used and by whom. Image variables are related to visual content, execution of visuals , context of visuals, and image formats.

3.1 Image functions

We know that visuals are perceived much more rapidly and readily than text (Fleming & Levie 1978, 1993; Sinatra 1986). Lester (1995:73) 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 papers have been published outlining functions of illustrations (for example Duchastel 1978; Duchastel & Waller 1979; Holliday 1980; Levie & Lentz 1982; Levin, Anglin, & Carney 1987; Pettersson 1989, 1993). All papers include the functions of attracting attention to and creating interest in a given material or in a given subject.

The material may be “appealing to the eye” (Duchastel 1983; Levin 1981); motivate a person to pick up, browse through, and read the text (Duchastel 1978, 1983); and making reading more enjoyable (Duchastel & Waller 1979). Evans, Watson, and Willows (1987) noted that the attentional role of illustrations is highlighted in teacher’s manuals and teacher’s editions of a variety of textbooks.

Visuals explain things and illustrate appearance. When visual discrimination is needed pictures are helpful in identifying the various parts. In many instances, pictures provide a much better overview and understanding of a subject than words. Visuals are great at designating spatial orientation, time and magnitude relationships, etc. Pictures may be cognitive and convey information to the reader

or viewer. They can facilitate learning from a text by enhancing comprehension and memory (Levie & Lentz 1982). Pictures can be used for instructing, exemplifying, identifying, providing variation, authority, and information as a supplement to text and sound. Pictures are often used for content that is important, hard to understand, and new to the readers. The effectiveness of a visual depends on the medium, on the type of information, and on the amount of time learners are permitted to interact with the material.

Pictures can be affective and provide readers with entertainment and reinforce an experience both positively and negatively. They can trigger associations and influence emotions and attitudes, especially in movies and TV. Pictures can be used to persuade, to flatter, tease, shame, scare, and seduce the audience (Zakia 1985). In advertising and television, pictures may carry subliminal messages. Ads for liquor or cigarettes, for example, sometimes use sexual symbols. Pictures can be compensatory, making it easier for poor readers to comprehend, learn, and recall things they read in a text (Duchastel 1978). The purpose of realistic pictures is normally to exemplify or illustrate something (Melin 1986a). Aronsson (1983) maintained that visuals employed in teaching aids for immigrants could conceivably play a major role in culture transfer.

Visuals may have a purely decorative purpose and be used for beautifying or adorning something (Selander 1988). In addition to purely realistic visuals, there are also visuals that can be described as “metaphoric.” They exemplify and depict some linguistic metaphor. Visuals of this kind are not symbolic in any semiotic (Jacobson 1976) or art science sense (Berefelt 1976). Melin (1986b) noted that metaphoric pictures are particularly abstract and therefore intellectually demanding. Illustrations can also be used to break up longer blocks of text and make the pages more appealing. Pictures may also have a generally decorative effect and be used to improve our environment. However, cognitive and decorative functions should never be confused or mixed. Massoumian (1989) concluded that: “haphazard use of visuals may lead to minimal or no instructional gain and gradual loss of effectiveness as an instructional tool” (p. 19). And Winn (1993) concluded that pictures play many roles in instruction. It is, therefore, necessary to know precisely what a picture’s function is intended to be before it is designed. The use of visuals does not automatically improve the achievements of the learners. For some objectives text is enough. It should be remembered that pictures can have a positive, a neutral, or a negative effect on the learning process (Levin et al. 1987; Sims-Knight 1992; Winn 1993; Rieber 1994). *At some point illustrations move from being engaging motivators to engaging distracters.* When too many pictures are used, readers may ignore many of them.

According to researchers in the areas of instructional message design, visual literacy, and visual communication the most common opinions on functions of

visuals concern *attention*: attract, gain, get, hold and maintain attention are mentioned by the researchers. Other common explanatory verbs are: *facilitate*, *provide*, *persuade*, *create* (an interest in), *illustrate*, *clarify*, *motivate*, *present*, and *reinforce* information (to someone). Most of these purposes can be looked upon as clearly pedagogical or cognitive, in contrast to pictures used for entertainment, decoration, advertising or marketing. The most common purposes of pictures in information design are to *visualize*, *clarify*, *inform*, *attract attention*, *facilitate reading*, *explain*, and *convey information*. The type of visual to be used in the production of materials for information and learning must often be determined in each case with a view to specific demands on the visual, and also to the prevailing budget framework.

Moving pictures can be *affective* and provide readers with entertainment and reinforce an experience both positively and negatively. They can *trigger associations* and *influence emotions* and attitudes, especially in movies and TV (Zakia 1985). In advertising and television, pictures may carry *subliminal messages*. Ads for liquor or cigarettes, for example, sometimes use sexual symbols (Zakia 1985). Leshin, Pollock, and Reigeluth (1992) noted the *attention-getting* capability of several visual devices. They mentioned zoom lens movement to emphasize important details. Other devices are split screens, shading and contrast, voice-over narration, text, and graphics. Leshin *et al.* (op. cit.) suggested that visual images can *facilitate* comprehension and retention of information through organizational, structural, and mnemonic (assisting memory) functions.

Rowntree (1990) identified *motion* as a valuable characteristic of video. The author suggested the following video applications in which movement is an important attribute:

- To *demonstrate* the operation of tools or equipment.
- To *demonstrate* skills that learners are expected to emulate.
- To *conduct* experiments in which the processes must be observed.
- To *present* a dramatic or musical performance in which it is necessary for learners to see as well as hear the performers.
- To *analyze* change over time using animation, slow motion, or time lapse photography.
- To *reveal* the spatial, three-dimensional qualities of an object or structure.
- To *transport* learners into situations that could not otherwise be experienced
- To *present* primary source material for analysis, such as archival film of historical events or videotapes of naturally occurring situations.

The contents of movies and television programmes are presented in a preordained fashion, decided on by the producer. This preordained fashion tends to *encourage passivity* in the viewers and to perform at a low cognitive level. The same is true

of prepared oral presentations, like formal speeches and rigid lectures. However, the reader of a book or a newspaper digests the textual and the pictorial information at his or her own pace. Interested readers are active and perform at a higher cognitive level. Readers that are not interested in the subject matter may easily become passive.

Interactive video programmes and multi-media presentations make it possible to combine sound and moving pictures in various ways. Thus, these media can *arouse considerable activity, enjoyment and commitment* in the user. Because an interactive video programme and a multi-media presentation can stimulate the user to perform at a higher cognitive level, it has the potential to function well, both as a conveyor of information and as a teaching aid.

3.2 Visual languages

It has probably always been natural for Man to express himself or herself by means of visual messages. Since the beginning of mankind we have been using body languages and different kinds of signs for communication. Prehistoric Man made murals and rock inscriptions with mythological meaning. In everyday life, people probably made drawings on the ground to show the location of game for their food. Simplified images ultimately evolved into characters, letters, and numerals. Pictures helped Man communicate long before we had written languages for our messages. Our children make pictures, they draw and paint long before they learn to read and write. To be able to produce a visual message in any medium it is important to understand the major characteristics, the possibilities and the restrictions, of visual language and of pictures. We need to know how visual languages are constructed, how they are perceived, and how they differ from verbal languages.

3.2.1 Visual content

Motifs, facts, “action”, drama, violence, time shifts, parallel events, metaphorical (symbolic) descriptions, the degree of realism, the degree of detail, the credibility of content, comparisons and statistics, movement, time, space, sounds (in the form of speech, music, and sound effects), and emotions are examples of variables related to picture content.

Before starting to design visual information, it is very important to define how the illustrations can be used. We need to decide if we will use photographs or artwork. The most important factors seem to be informational and learning objectives and user characteristics. Visuals may not always be really necessary but are useful in many situations. However, in some situations, all kinds of pictures

may be distracting. In these cases visuals should not be used. In the design and production of visuals for instruction or for education, pictures must contain the information they are intended to convey. The visuals must be relevant to the situation. Without clear content, the visual will not be able to function well. We should carefully define the objective of each visual. What information or knowledge is the visual intended to convey? Who is the sender? Who are the receivers? And in which medium or media is the visual to be distributed? Cues for understanding the message in a visual are different in various cultures as well as in different socioeconomic groups. It is important to consider these factors in each specific situation.

Messages including visuals are preferred by most subjects and 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. A well-defined structure of content facilitates learning. There is a need for structure in complete material as well as within parts of the material. Normally the structure of an instructional message is built to be continuous, to form a connected whole that presents the message clearly to learners. The instruction progresses logically, step by step. After an initial orientation or instruction, instructional materials should develop at a pace that is suitable for the intended audience.

A major factor in instructional effectiveness is repetition. Also, summaries will help learners to remember the most important points of the specific subject matter. Background colours, shades, frames, and special use of fonts and type size can be used to achieve unity. When the learner doesn't see, read, or hear what she or he expects to see, or can't find agreement between verbal and visual content, the message is likely to be misunderstood. Since the competition for our attention is very fierce in commercial arts and in advertising, discontinuity is often used intentionally to attract and even to hold attention. The intended message may be hidden within verbal or visual puns, metaphors, satires, parodies, or humor. In these cases, designers break the traditional rules of instructional design. It might also be possible to use the unexpected to attract attention to instructional material as well.

3.2.2 Execution of visuals

Visual languages have analogue coding employing combinations of basic graphic elements (dots, lines, areas, and volumes) for depicting reality. A given set of basic elements can be combined to form completely different images. Visual languages attempt equivalence with reality. Visuals are iconic. They normally resemble the thing they represent. Meaning is apparent on a basic level, but the visual language must be learned for true comprehension. It may take only 2–3 seconds to recog-

nize the content in an image (Paivio 1979; Postman 1979), but 20–30 seconds to read a verbal description of the same image (Lawson 1968; Ekwall 1977) 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. Informative pictures should always be designed so they are easy to read. The goal should be *clarity of communication*. As previously noted several authors have pointed out that “*form follows function*”. To make life easier we want to have products with as good function as possible. However in message design the subjective tastes of the individual designers are often allowed to dominate, sometimes with a serious malfunction as a result. Mijksenaar and Westendorp (1999:5) discussed instructional design and they concluded that the language of visual instruction remains very primitive, with a limited number of signs and a weakly developed grammar.

In *camouflage* the intention is to make a figure as much like the background as possible. Thus camouflage is the opposite of information design, it is *disinformation design*. Tufte (1997) discussed *magic*, the production of entertaining illusions. He noted that magic is to engage in disinformation design (p. 64). So here inventory of conjuring methods provides evidence about what not to do in information design. When visuals are produced for informative purposes, it is always a good idea to start by trying to “visualize” the information to be conveyed. “Visualizing” a message means that you attempt to materialize it in an effective synthesis of words and pictures. So visualization is always a composite task, never a single act on its own, and requires the collaboration of several different parties. Dondis (1973) discussed the anatomy of a visual message. We express and receive visual messages on three levels: (1) representationally, (2) symbolically, and (3) abstractly. Representational forms of illustrations are actual photographs of things. In symbolical forms pictures show one thing and connote another. In abstract forms illustrations provide minimal visual information on the phenomenon illustrated.

Visuals that are attractive and that people like also have greater impact. To increase interest in a material it might be a good idea to use a blend of several kinds of visual types such as diagrams, drawings, photos etc. Generally speaking it is not possible to rank the different types of visuals. Often the type of visual which should be used must be determined in each individual case with a view to various demands on the picture and the prevailing budget framework. It is often easier to control the production of a drawing than the production of a photograph. So a drawing may be the only realistic alternative in many instances. However, since pictures illustrated in more abstract styles, such as cartoon and expressionistic, might generate more imagination such pictures might be used as stimuli for creative writing assignments.

It can be concluded that effective visuals for information should create an experience for the reader. The reader must:

- See or rather “discover” the picture,
- Pay attention to the picture, and
- Actually read the picture in an active and selective way.

Picture type (drawings, paintings, photos, etc.), size, shape, colour (hue, value and saturation), contrast, texture, light and shadows, emphasis, composition, perspectives, technical quality, texts in pictures, pace, speed changes, editing, zooming in, zooming out and panning are examples of factors related to execution of visuals. An artist or a painter producing a picture may use lead, crayons, India ink, various kinds of paint, paper, canvas, and several other kinds of material in a variety of different combinations. The image is gradually produced by combinations of dots, lines, and areas. The actual picture is built up from materials and pigments which, according to intentions, can be completely separated or gradually mixed. In computer-based systems *bit-mapped pictures* consist of picture elements defined by their positions while *object oriented pictures* are defined by algorithms.

In addition to size, shape, colour, etc., the way pictures are shot is important. The aesthetic value of a long shot is different from that of a medium shot or a close-up. According to Zettl (1990) a scene can be presented (1) objectively (usually a long shot), (2) subjectively (usually a close-up), or (3) creatively (created by the medium itself, for example, superimposition, picture montage, etc.). Metallinos (1990) has developed a schema which explains these three forms of picture presentations in accordance with their functional aesthetic value. We can (1) remain totally objective and look at an event, (2) become subjectively involved and look into an event, and (3) where the event is totally dependent on the medium for its existence, we can create an event.

3.2.3 Context of visuals

A verbo-visual message has both internal and external contexts. Factors inside the medium (internal) provide (1) the *inner context* such as text, speech, music, sound effects, or other visuals. Our attention is on either the sound or on the image when we view a film or a TV program. 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 just impossible for viewers not to be influenced by the film.

When we read a book or view projected images the lighting in the room may exemplify (2) the *close context*. In an oral presentation the audience is influenced not only by the presenter and her or his projected images but also by the tem-

perature, the furniture, the room itself, outside noise, noise from the projector, and noise from other persons. The lighting conditions may be the most important variable for our perception of all kinds of images. A projected image is perceived as having high image quality in a dark room. When the light increases, the perceived quality decreases. A printed image is perceived as having high image quality in a light room. When the light decreases, the perceived quality decreases.

The entire communications situation, i.e., the senders and their intentions for the verbo-visual message, and the receivers and their cultural, economical and social circumstances provide (3) the *social context*. The close context and the social context are both *external contexts*. The context in which a message is presented has a major impact on the way the message is perceived. Perception of brightness, colour, size, shape, pattern, and motion have all been shown to be influenced by contextual variables. One and the same visual may be perceived in different ways in different contexts. A single picture taken from a series of pictures may be hard to decipher, but the visual's content becomes easier to comprehend when that picture is returned to its proper sequential context.

3.2.4 Image formats

Our perception of a visual is affected by its medium, e.g., as a photograph, a printed image, a slide projected on a white screen, and a computer-generated image. A movie evokes different perceptions when a viewer watches it alone on a TV-set, or in a crowded movie theatre with a wide-screen and high-quality sound and images. An image is a multidimensional representation of an inner or an external reality, depicting the physical structures of the objects or events it represents. Mirror images and other virtual images, created by mirrors, lenses, and other optical systems, can be seen but not “captured” and shown on a screen of any sort. A virtual image is located at a point from which divergent light beams seem to start before they have passed the optical system. Like our inner images, e.g., memories, virtual images lack an obvious physical format. All other kinds of images have a physical format.

In technical systems the whole motif may be captured at once with a traditional camera, or it may be scanned line by line with a TV-camera. Except for the printing of line drawings, all other pictures have to be divided into small elements, picture elements, or pixels, in the technical process of duplication. The image has a vertical (y) and a horizontal (x) resolution, and it has also a “depth resolution” (z).

An individual pixel may vary with respect to shape, size, position, value, grain, colour, and grey scale. Normally these pixels are very small. At normal reading distance they can hardly be seen. In fact *an image with good quality must have a resolution that is better than that of our own vision*. It takes time to read an image.

This *inertia* enables us to see the motion in the stills which comprise movie film and television.

3.3 Creating images

There are many ways to create images, pictures and visuals. Main production tools include pens, pencils and other materials for manual work with pictures. We can use computers and suitable software to create and process images. We can also use cameras; still, film and video. Regardless of the medium some characteristics and some guidelines apply to all kinds of visuals.

3.3.1 Graphical elements

The most simple elements making up a visual are dots, lines, and areas. These elements can vary in a great many ways. Whether a graphic element is defined as a dot, a line, or an area is related to the size and the scale of the specific visual. Obviously, the borders between dots, lines, and areas are not at all distinct. Three-dimensional visuals also have volumes. Dots, lines, areas, and volumes all have various properties. The simplest image components should be arrayed so that the picture's message is brought out as clearly as possible. This can be combined with high demands on aesthetic quality. However, it is difficult to make any general recommendations on how various drawing styles should be used. Fine details in the texture of a drawing disappear in the dot screen structure of the printed image. Even more detail is lost in a television image and an image on a computer screen. In order to save money, pictures could be tailored to the technical limitations of the systems that are used to make originals, masters, and print runs in the respective medium/distribution channel.

3.3.1.1 Dots

Mathematically a *point* is a location, defined by the crossing of two very thin lines. Any point has an exact position in a specified context, an exact coordinate on a plane. However the point has no size, no shape, no colour, no value, and no grain. A point is often represented by a *dot*, which is the smallest graphical element in visual language. With respect to the technique and the different types of visuals, dots can vary in size, shape, colour, value, grain, context, as well as position. Usually single dots do not carry any meaning. They are non-significant.

A single dot can direct our attention within a picture. It can also provide harmony or stress to a given composition. A group of dots may suggest motion and direction in the picture. The ability of a series of dots to direct our attention is



Figure 3.1 Dots. When dots are close to one another they form a line.

greater the closer the individual dots are to one another. When the dots are really close, they cannot be individually recognized any more (Figure 3.1). A series of dots form a line. A line can also be defined as the “track of a dot in motion” or a “visual record of the path of a dot”.

In printing technology, graphic elements may be defined as type for letters and lines, and screen points for visuals. In work with digital images in computerized image processing, graphic elements can be defined in one of two systems: either mathematically as points and vectors, defined by cartesian coordinates, or in the form of pixels (minute rectangular picture elements used in “building blocks”), defined by raster coordinates. A vector can be assigned basic graphic properties in the same way as attributes in display fountains, but it has as such only mathematical properties. A pixel is in fact a minute area and can vary with respect to colour. Dots, lines, areas, and symbols, such as letters, are composed of several pixels.

When we look at a printed picture, a television image or an image on a computer screen, our minds combine the dots by blending and organizing the patterns into correct images. This subconscious process is called *visual fusion*. When placed in patterns known as “halftones”, printed dots are perceived as continuous and solid values and hues.

3.3.1.2 Lines

A line may be varied with respect to its starting point, length, direction, curvature, shape, thickness, evenness, points of change, printing, colour, value, grain, brightness, orientation, terminus, and context. The line is a powerful graphical element. Readers have a tendency to follow a line along its way. As a result lines can be used to direct attention to specific picture elements. The line provides the essential elements for perception of motion in a visual.

Since we read from left to right, and from top to bottom in the western cultures most people here will see the upper or left end of a line as its beginning and starting point, and the lower or right end as the ending point or terminus. A line can also be a border between two areas in a visual, and separate, and group picture elements. Since we always perceive graphical elements with respect to the specific context, the meaning of a simple and single line will vary. A horizontal line can serve, e.g., as a horizon, a street, or a sea. (Figure 3.2).



Figure 3.2 Lines 1. A horizontal line can serve, e.g., as a horizon (left), a street (middle), or a sea (right).

Vertical and horizontal lines, parallel to the borders of the picture give the impression of calm and stability. Horizontal lines are restful and relaxing and creates a strong sense of equilibrium in any composition. Vertical lines are also symbols of power. They often stop eye movements. Diagonal lines are unstable and attract the eye. They give the impression of movement, creating visual stress. Artists may use this implied motion when they wish to convey energy or action in their works. There is a tendency for curved lines and smooth shapes to stand out more than straight lines and shapes made out of straight lines. Lines that reach out from one point in different directions may be perceived as aggressive or violent. A thick and heavy, or bold line, is more powerful and strong than a thin line. There are several good reasons for using lines in drawings.

- Line is the natural way to draw. Infants begin with line and adults continue throughout life.
- Line drawings are the most readily recognizable form of depiction in general.
- Line is a quick way to visualize ideas.
- Line needs a minimum use of time and material.
- Line drawing materials are least expensive.
- Line emphasizes the basic structure and composition of a drawing.
- Horizontal lines imply calm and stability.
- Most lines are restless and never static, and may imply motion and action.
- Other drawing techniques may be added.
- Lines can connect different picture elements in schematic pictures.
- Line can take many different moods.
- Line is a tool for notation systems.
- Line describes shape.
- Line drawings are effective stimuli for learning. Line drawings are most effective in formats where the learner's study time is limited. More realistic versions of art work, however, may be more effective in formats where unlimited study time is allowed.

Artists often use several different kinds of lines in the same picture. If all the lines have the same thickness and tone, the picture may seem “lifeless” and rather bor-

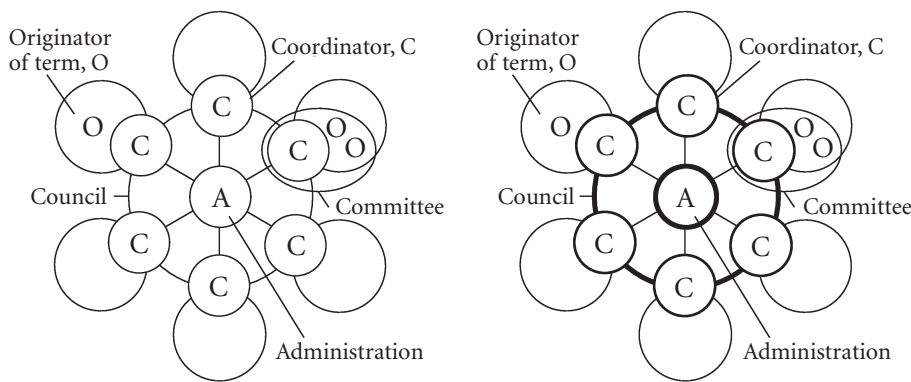


Figure 3.3 Two illustrations of the organization of terminology work; with and without differentiation between lines. The right picture is more distinct than the left picture. Compare with Figure 3.6.

ing. It is possible to show importance using different weights, or line thickness (Figure 3.3). A thin and light line is like a whisper. A bold and heavy line is like a “shout”, or a “yell”. Depending on its boldness, and looseness a line may express a wide variety of emotions. In many situations it is important to differentiate between lines in illustrations. In schematic pictures 0.5, 1, and 2 points are usually suitable gradations for line thicknesses for copied documentation. We can not easily distinguish between more than three or four line thicknesses in the same picture. It is often said that Picasso was a “master of line”. There is a special elegance in the way he expressed the topography of the world. As a rule of thumb, a three-step gradation is sufficient to differentiate between lines that illustrate different information in a technical illustration. The number of line thicknesses may increase in printed materials.

Tufte (1997:73) suggested the design strategy of the *smallest effective difference*: “Make all visual distinctions as subtle, but still clear and effective”. For overhead transparencies the corresponding gradation of line thicknesses is at least 1, 2, and 3 points. However in a large auditorium, with a great distance between the screen and the people at the far end of the room we may have to use 2, 4, and 8 points, or even thicker lines. In most situations we should avoid too bold lines, we do not have to “shout” at the audience. According to Tufte (1997:74) the

idea of the smallest effective difference helps in designing the various secondary and structural elements in display of information – arrows, pointer lines, dimension lines, tic marks, scales, compass roses, broken lines for incomplete elements, grids, meshes, rules, underlines, frames, boxes, compartments, codes, legends, highlights, accents, bevels, shadows, and fills defining areas and surfaces. Mut-

ing these secondary elements will often reduce visual clutter – and thus help to clarify the primary information.

In schematic pictures and symbols we may usually use continuous lines. We should avoid the use of various screen patterns, especially those that are screened diagonally. Lines may usually be solid. Lines screened diagonally are often indistinct, and are sometimes not legible at all. If screens must be used in lines, the thickness of the screened lines may be at least 4 points, preferably even thicker, to be seen clearly in the printed material. In overhead transparencies we can use even thicker lines (Figure 3.4).

Be careful how you place graphical picture elements in schematic pictures. An important rule to consider in information design is: $1 + 1 = 3$, or sometimes even more. Two black lines that run closely parallel to each other can easily be interpreted as three lines, two black lines with a white line between them. Two lines that cross each other can be interpreted as four lines. They may even be perceived as four rectangles or four triangles. Too many lines can cause disturbing interference effects. We may restrict the number of lines to a minimum in each picture.

Lines that *connect* different picture elements or show a particular relationship in schematic pictures can be shaped differently or placed in different ways. However, this should be done in a systematic, and carefully prepared way. When lines connect to other picture elements, the connection should be distinct, without unsightly or misleading “looseness”. Sometimes several parallel lines may be required for the connections. These lines may be similar or dissimilar. Lines can link together the geometrical *mean-distance points* of the elements of a picture. This first method can be used for all types of geometrical shapes: such as ovals, circles, triangles, rhombi, squares, and rectangles. In the second method, the lines link together the *focal points* on the sides of the picture elements. Linkage of the focal points lends balance and harmony to the schematic picture when the picture elements are squares and rectangles. In the third method, the points of linkage are *equally distributed* along the sides of the picture elements. This method is ap-



Figure 3.4 Line attributes. In picture elements for schematic pictures it is usually better to use a solid and continuous line (left) than a line filled with a texture or screen raster. In this example all lines are six points. The four ovals in the middle have poor legibility.

propriate for all picture elements with right angles, but the method is difficult to use if the picture elements are rounded in shape, such as circles and ovals. Preferably, the various methods should not be mixed, in any case never in the same schematic picture.

Lines that are meant to show a *flow of events* should display one or two arrowheads that proceed from one picture element and point to another. Arrowheads can have different forms. The connection to the shaft can be perpendicular, concave, or convex, and the length of the head can vary. To achieve unity we should avoid mixing various types of arrowheads in the same schematic picture. The perpendicular connection works well enough. Two-way arrows are only used for specific purposes.

3.3.1.3 Areas

An area can be varied with respect to size, “emptiness”, shape, colour, value, grain, texture, shaded, non-shaded, grey scale, colour combinations, brightness, and context. Roundness is the most common form in nature. When ink, water, or any other liquid material is dropped on a surface, it assumes a rounded form. The American painter Chuck Close has made some portraits using his own fingerprints. These pictures are built up by thousands of small “areas”. An area may be described by a line forming a shape. It may also be described by a shade or by a colour. An area may have a geometric, an abstract, or a representational shape. In art, shapes are often used to represent the real world. Picture elements with bold lines are perceived as more important than picture elements with thin lines. And a contrast-bounded figure is perceptually superior over a line form.

In schematic pictures we should avoid using more than five colours, grey tones, or screen patterns in different areas in the same picture. Appropriate scales might be: (1) white – grey – black; and (2) white – light grey – grey – dark grey – black. When the final production is made with copying machines we should usually use only the first of these two scales. To the extent that colours are used, they should be clear and distinct, and they must be chosen with great care. Squares and rectangles are rare in nature.

The size of an individual area is always relative. It depends on our knowledge of its surroundings. A square is an example of a static area. A rectangle is perceived as more active than a square. The size of a circle means little to us. A hand gives the circle the size of a tennisball. Lines around the circle make it the size of the sun. The size of a single rectangle means little to us. However, a person sitting behind the rectangle gives it the size of a desk. A car next to the rectangle makes it the size of a garage, or a small box if it is a toy car (Figure 3.5).

Emptiness or “space” is the part of a visual that is not filled with picture elements. This part of the picture is called “negative space” or “passive space”. The

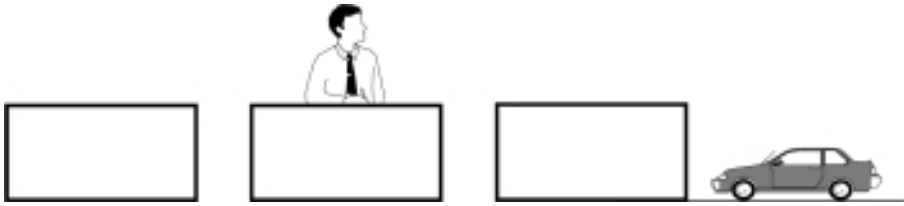


Figure 3.5 Areas. The size of a rectangle (left) means little to us. A person sitting behind the rectangle gives it the size of a desk (middle). A car next to the rectangle makes it the size of a garage, or a small box if it is a toy car (right).

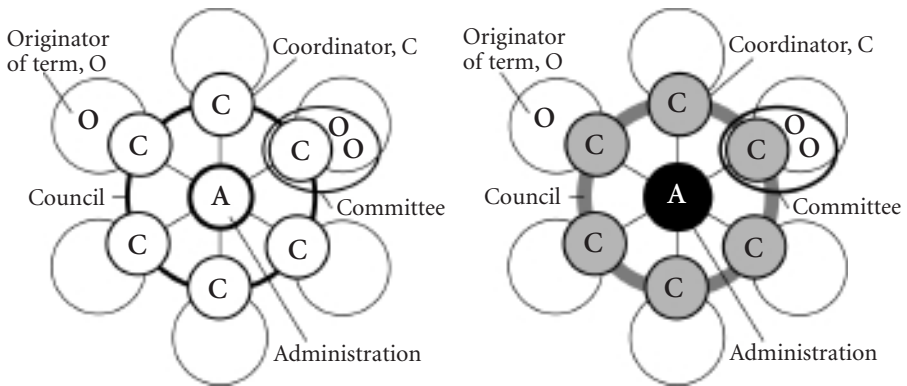


Figure 3.6 Line thickness and areas. An illustration from real life (the organization of terminology work), with differentiation between lines (left), and with differentiation between lines and areas (right). The illustration can be further improved by using colour. Compare with Figure 3.3.

negative space is usually the background. Space has no meaning in itself, but it may be used to separate or bring together different picture elements. The areas representing different objects are called “positive space” or “active space”. The most important elements of the visual may be emphasized so as to enhance attention and perception (Figure 3.6). We should design all visual material taking into account dots, lines, and areas, so that the important content will stand out and be easy to perceive.

3.3.1.4 Volumes

A volume has a three-dimensional form. The form may be actual or simulated. In two-dimensional representations of three-dimensional objects, shadows are key cues for simulated volumes. We structure the three-dimensional field into various depth planes, or grounds, a foreground, a middleground, and a background. Like lines and areas, volumes also have several basic properties, such as size, form,

colour, surface, structure, contour, direction, weight, position, material, light, architecture, stability, balance, proportions, gravity, and context. It may be a good idea to study the works of good artists, painters, and sculptors. Most artists use many of the possibilities in the visual language. However, some artists have made paintings, drawings, etc., using mainly one or two different elements with limited basic properties. Here are just a few examples. Vincent van Gogh only used dots and lines in some paintings. In numerous paintings, Roy Lichtenstein used the screen of dots and lines from comics in newspapers. Paul Cezanne used hues in different areas.

Pablo Picasso is most well-known for his paintings, in which he often used areas in different shapes. Picasso was, however, very active also in other fields. He introduced “construction” in sculpture. He assembled pieces of wood, cardboard, paper, string, and other materials. Thus, Picasso gave sculpture a potential freedom which is not yet fully explored. Marcel Duchamp used everyday objects like the famous “Bottle Rack” directly as a sculpture. Auguste Rodin was the master of modeling clay, with special articulation of the surface of the sculpture. Replicas of his sculptures can now be found in many countries. Constantin Brancusi exploited Rodin’s discovery of material as the fundamental determinant of form. He explored materials like timber and stone, and used forms inherent in these materials. He also used polished bronze. Like Rodin also Edgar Degas emphasized gravity in his sculptures. Henry Moore was a master of lines and volumes in his sculptures. In his sculptures there is an intense interaction of space, light, shadows, contours, balance, composition, proportions, relations, and stability.

3.3.2 Size

It is easier for us to distinguish between lines than between areas or volumes. When we judge the size of objects, e.g., areas, we are apparently most influenced by the length of horizontal lines or horizontal distances. In most contexts the differences in the sizes of circles, squares, triangles, ellipses and other two-dimensional symbols are underestimated. *Size constancy* is our tendency to judge the size of an object as the same despite changes in distance, viewing angle, and illumination.

In materials for information, the size of a visual should never be decided with respect to “available space” or “prettiness.” The size of a visual should be decided with respect to the possibility to communicate the intended message. For example, illustrations in textbooks for early grades are both large and frequent. In later grades the visuals are smaller and less frequent. Quite often readers will interpret the size of a visual as a measure of importance. By tradition the bigger a picture is on a page the more important it is considered to be. However, a visual should

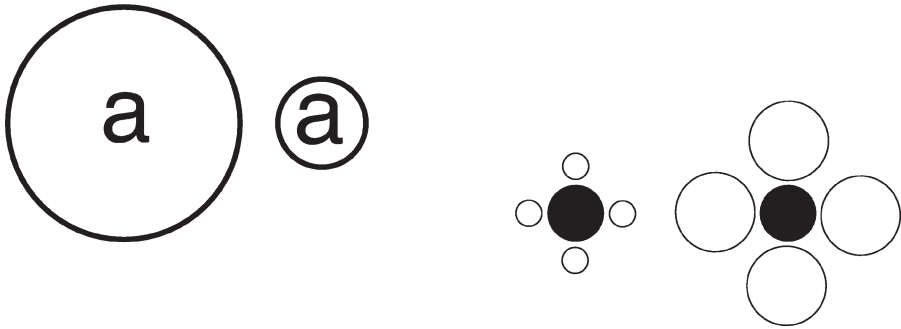


Figure 3.7 The perceived size of an object is relative to the size of nearby objects. Above, the letter ‘a’ is equal in both contexts, so is the dark circle in the other pair.

neither be too small nor too large. There is an optimum size for each visual. The size must be large enough for the image to be legible.

A visual with a “large content” and many details must be larger than a visual containing a more limited amount of information. If one picture is larger than the others in an array, this picture will attract the most attention. “Noise” in the visual results in a need for a larger size. A picture that is four to five centimetres wide in a book corresponds to the eye’s perception of the width of a television screen at a normal viewing distance and is adequate in some cases. In television the spectacle of things is de-emphasized, but human actions gain prominence. A large Cinemascope image is more overpowering than the small television image. In film, people as well as objects attain spectacular dimensions. Increasing the size of illustrations by projecting them does not automatically improve their effectiveness in facilitating the achievements of the learners.

The most important part of the subject must be large and clear, take up a large proportion of the image area, and be perceivable as an entirety. Large visual elements attract the attention of the reader. The perception of size is influenced by colour and grey scale. Open and light forms are perceived as being larger than closed and darker forms of the same shape. The perception of size is very much influenced by contextual variables (Figure 3.7). There can be no large without small and no small without larger.

We need to show the scale and the contrast. It is usually a good idea to include some familiar object to supply the scale for judging the size of an unfamiliar object. People vary greatly in their ability to perceive proportional relationships. The perceived size of an object is relative to the size of other objects. The size of unfamiliar objects is perceived as relative to the size of familiar objects. Sometimes it is possible to include a scale in the visual. Any simple and distinct part of an image can be visually superimposed to measure proportional relationships of the whole. In caricatures, however, proportions are deliberately made wrong.

The perception of size is related to perceived distance, and the perception of distance is reciprocally related to perceived size. Regardless of distance there is a constancy in the perception of the size of known objects. This is called *size constancy*.

3.3.3 Shape

There are three basic and fundamental shapes: the circle, the equilateral triangle, and the square. The basic shapes express visual directions. Circles suggest curved directions, triangles suggest diagonal directions, and squares suggest horizontal and vertical directions. Basic and regular shapes are dominated by irregular and unpredictable shapes. These shapes attract more attention. There is a considerable difference between the interpretation of symbols by subjects, and the intended meanings. We cannot find a spontaneous and unambiguous correlation between colour and shape. There is a large degree of perceptual constancy in the perception of shape. *Shape constancy* is our tendency to judge shapes as the same despite changes in distance, viewing angle, and illumination.

3.3.4 Colour

Colour can be described in technical, physiological, psychological, and aesthetic terms. Hue, value, and saturation are three important components of colour. To some extent it is a language of its own. Colour can be used as an important and a successful part of information design.

3.3.4.1 Hue

When we talk about the colour of an object we usually refer to the hue of that object. Most people are familiar with hue through our labelling of colours such as red, orange, yellow, green, blue, and violet. Hue *is* colour. In colour description systems hues are usually placed in a band around a centre, in a “colour-circle”. Different wavelengths of light reflected off an object are responsible for the hues. All of the colours in the rainbow are hues in the visible spectrum of light. It is possible for us to see the difference between several million colours. However, we can only distinguish between about 10,000 different colours, and only between about seven colours in the same field of view at the same time. Yellow-green lies in the region of the eye’s greatest sensitivity. Sensitivity decreases markedly toward the red and blue ends of the spectrum. Our perception of colour is strongly influenced by and dependent on contextual variables such as the lighting conditions and other surrounding colours.

A black and white picture represents reality in a different way than colour pictures do. In black and white, all colour is translated into values of grey. Hue adds the “colour-dimension”. Hue may also act as a formal element in a composition, and direct the attention of the viewer.

3.3.4.2 *Value*

Value (sometimes called tone) is the apparent lightness or darkness in anything that is visible. It ranges from white to black (Figure 3.8). In nature there are hundreds of steps in value. However, we can only distinguish between a limited number of levels of value. Pictures derive a simulated natural tone from pigment, paint, or nitrate of silver. There is an element of value in colour pictures, as well as in black and white pictures.

In colour description systems values are usually placed on a vertical scale, from white to black (Figure 3.9). It is not easy to distinguish between more than ten shades of grey. In printed materials grey is a combination of black ink and white paper, measured as a percentage of full black. Bertin (1967) recommended the following steps in scales, with three to ten steps, from white (W; 0% black) to black (B; 100% black):

A grey scale can usually serve the same function as a colour scale in a map. A colour scale, however, may be nicer and more attractive. Value is more important to contrast than hue. According to Dondis (1973) the broadest range of dis-



Figure 3.8 A tonal scale 1. An example of an eight step tonal scale, from white to black.

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Figure 3.9 Tonal scales. Examples of tonal scales, from white to black.



Figure 3.10 Perception of tone. Our perception of any specific tone of grey, or any colour, can change when it is placed on a tonal scale.

tingtly different grey tones in pigment is about thirtyfive. Without light upon it, the whitest of whites will not be seen at all.

A “high key” picture is composed with mainly light values, and a “low key” picture has mainly dark values. Value may be used to express emotions, form, space, and movements as well as to give the illusion of light. Each colour has its own tonal value. Our perception of any specific tone of grey, or any colour, can change when it is placed on a tonal scale (Figure 3.10).

3.3.4.3 Saturation

Saturation is defined as the apparent purity or lack of greyness of a colour. A bright and pure colour is *saturated* and has no grey at all. A colour with some grey is *less saturated*. A lot of grey gives an *unsaturated* colour. A black and white picture is an example of a totally unsaturated picture. The amount of saturation does not influence the basic hue of a colour, and it is not related to the value. Saturation is sometimes called chroma, and sometimes called (colour) intensity. Sometimes, however, chroma is said to be the combination of hue and saturation.

In colour description systems saturation steps run out in horizontal rows, from the vertical value-scale. Saturated colours are often considered to be aggressive, bold, daring, vibrant, and they may grab our attention. Unsaturated colours may be perceived as boring, dull, peaceful, restful, soft, weak, and they may sometimes be perceived as depressing. Unsaturated black and white pictures are often used to represent the past. Highly saturated colours are frequently used to depict the future. Boldly coloured objects seem closer to us than unsaturated colours.

Colour variations take the natural form of a triangle, a “colour-triangle”. At the top corner is white. Black is at the bottom corner. At the third corner is the pure colour of the specific hue (for example red). A mix of a pure hue and white gives a *tint*. A mix of a pure hue and black gives a *shade*. A pure mix of white and black gives *grey*. A mix of all three colours (white, black and the specific hue) gives a *tone*. *Colour constancy* is our tendency to judge surface colours as the same despite changes in distance, viewing angle, and illumination.

Looking at a picture printed in colour on paper we experience a *subtractive colour combination*. The inks, dyes, and pigments function like filters for the white

light. The light is absorbed in different ways. When printing on white paper, yellow and red ink produce orange. Blue and yellow create green. Red and blue give purple. Yellow, red, and blue will become black. Since black ink is used for printing of the text, it is also used for the printing of pictures. The black ink gives the picture a distinct sharpness and more solid dark parts. To achieve the best possible print quality the red colour that is used (magenta) is somewhat violet, and the blue colour used (cyan) is somewhat light. Painters have the three hues red, yellow, and blue as their “primary colours”. With them they can mix paints of other hues.

A picture tube or a cathode ray tube is the unit that produces and shows the picture on a traditional TV-receiver, computer, or terminal screen. The picture tube consists of an airless glass-tube. Its rear end contains a device which emits electronic rays, while the front part forms the screen. The back of the screen is illuminated when hit by the electrons; and, by steering the ray over the screen, a picture is built up. For colour synthesis in a picture tube a range of colours can be produced by the additive combinations of red, green, and blue radiation. The *additive colour combination* starts in dark adding light to produce colour.

3.3.4.4 *Colour description systems*

The relationship between hue, lightness, saturation, and brightness is very complicated. For practical use in art and in industry, several different systems providing numerical indexes for colour have been developed. The most important ones will be mentioned here.

The Munsell System was introduced in 1905 and has been modified several times. The system consists of fixed arrays of samples which 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. Hue is represented by forty equal steps in a circle. The value and the hue are related to each other by a maximum of sixteen “saturation steps”.

There are many theories about how perception of colours actually works. In 1807, Young proposed a trichromatic colour vision system. In 1924, Young’s theory was formalized by von Helmholtz, who proposed hypothetical excitation curves for three kinds of cones in the retina, sensitive for red, green, and blue. In 1925 Hering based his “natural system” on man’s natural perception of colour that presupposes two pairs of chromatic colours blocking each other, red/green and blue/yellow. This model is the principle for the Natural Colour System (NCS), developed during the 1970s in the Swedish Colour Center Foundation in Stockholm (Hård & Sivik 1981).

From a perceptual point of view, Man perceives six colours as “pure”. Black and white are achromatic colours. Yellow, red, blue, and green are chromatic colours. These six colours are called elementary colours. All colours that are not

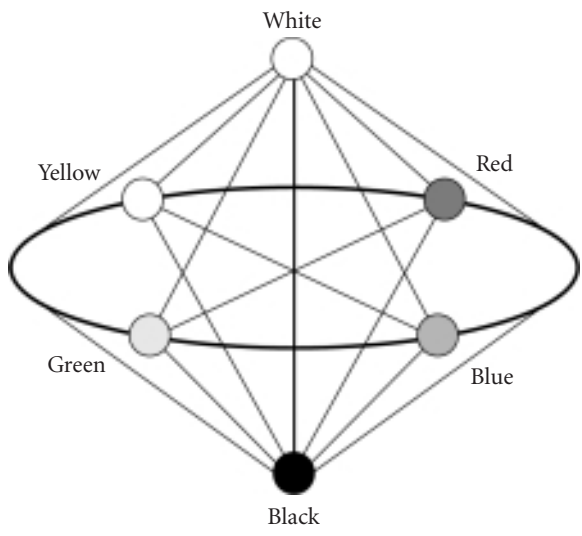


Figure 3.11 The NCS Colour Solid with the six elementary colours. Yellow, red, blue, and green are all located on the circumference of the Colour Circle. The Colour Triangle is any vertical sector through half of the NCS Colour Solid, such as, e.g., white – blue – black – white.

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” (Figure 3.11).

The chromatic elementary colours yellow, red, blue, and green are all located on the circumference of the Colour Circle (Figure 3.12). Each quadrant can be divided by one hundred steps, thus describing the hue of a colour. 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). 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 places emphasis on qualitative variation in the colour sensation whereas the Munsell System is based on equally spaced visual scales. Both systems are based on surface colours.

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

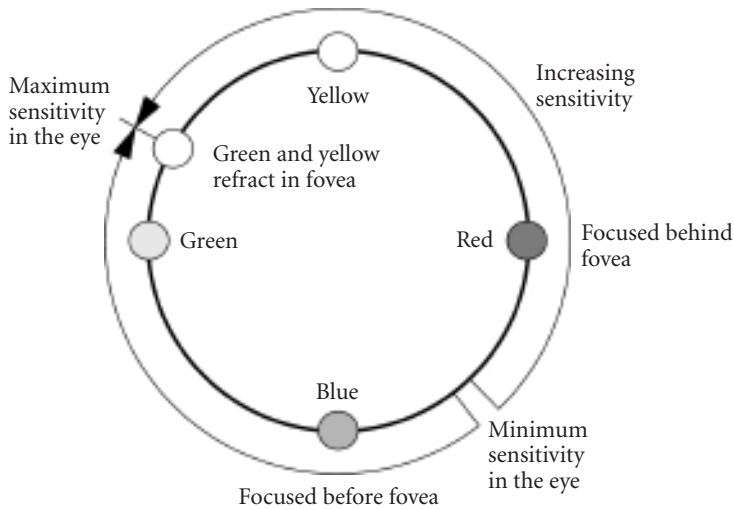


Figure 3.12 The NCS Colour Circle combined with information on the eye's sensitivity.

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 utilizes another coding (Samit 1983). Value is defined as the relative lightness. White has full value and black has no value at all. 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.

3.3.4.5 *Colour visibility*

Colour saturation influences our perception of shapes and objects. When colours of equal intensity are compared, the most visible hues are white, yellow, and green – in that order. The least visible hues are red, blue, and violet. In information graphics and statistical presentations, the most important elements should have the brightest colours, with the best contrasts to the background. In multi-colour map design, the contrast effect of different hues provides the most dominating visual clue in differentiating different symbols. The most legible combinations of print colours is black or dark brown text on a light yellow background. Other combinations may attract more attention but are less legible.

3.3.4.6 *Attentional use of colour*

Even if colour is not adding any information, it may still be contributing to better learning, because the interest for the picture may increase. There are many ways

to use colours to get attention. A dark dot in a light field, or a jog in a line are examples of emphasis. The more dots, the lower the degree of contrast and the less effective the emphasis. The contrast should be clear. This is regardless of the colour chosen and the colour-contrast effects. The symbolic meaning of colour vary from culture to culture. European cultures put on black to mourn a death while Asians wear white for the same occasion. In Western European cultures blue is a symbol for authority or calmness. Yet, in Japanese culture it connotes villainy, and in Arabic cultures blue symbolizes virtue and truth. We should be careful when using colours, especially when the context may suggest religious or social interpretations. It is a good idea to design visuals that work well in black and white, and then add colour to make them work even better.

3.3.4.7 *Colour preferences*

Fleming and Levie (1978, 1993) noted that people prefer surface colour hues according to this ranking: (1) blue, (2) red, (3) green, (4) violet, (5) orange, and (6) yellow. Children prefer colour hues that are light, distinct, and shining better than those colours that are dark and gloomy. Colour intensity should be strong and colour contrast should be clear. People in different cultures and in different socio-economic groups use colours in different ways and with different meanings. In cultures in Africa, in Central and South America, and in Indonesia, bright colours and high contrast are common in illustrations.

3.3.4.8 *Affective use of colour*

Colour enhances the perception of a visual message. If people like the contents in a picture, they like them even more in colour (Fleming & Levie 1978, 1993). From many experiments, it is clear that people prefer visuals in colour. Advertising is known to be much more effective when visuals are in colour than in black and white. Tests have indicated that viewers feel that they have a better understanding when television images are displayed in colour, although the use of black and white sometimes would be sufficient. However, an improper use of colour can produce negative results: it can be distracting, fatiguing, and upsetting. Yellow, orange, and red are perceived as *warm* and active hues. Red evokes feelings of strong emotions. Violet, blue, and bluegreen are seen as *cool* and passive hues. Blue is often used to represent truth and honesty. White is often associated with innocence and pureness, and black with evil and darkness.

3.3.4.9 *Cognitive use of colour*

For some learners and for some educational objectives, colour improve the achievement of the learners. However, in some cases the added cost of colour will not at all be justified. Colour is important in a visual when it carries information

that is vital to the contents in the visual. It is, for example, easier to learn to distinguish between various species of birds and butterflies when colour illustrations are used, instead of black and white illustrations. Highlighted information tends to be better remembered. Colours can easily be used for highlighting, separating, defining, and associating information. In line drawings or in black-and-white photos, for example, the addition of one colour may be very efficient. To avoid confusion and misunderstandings, it is important that colour be used consistently. Colour is capable of enhancing communication and adding clarity and impact to a message. In spite of the large quantity of research, colour perception still only seems to be partially understood:

- People might see colours in the same way. However, no two persons *experience* colour in precisely the same way.
- The human reactions to colour stimuli cannot be standardised.
- Depending on sex, age, profession, and culture, there are different subjective reactions to colour.
- There are likes and dislikes of colour, based on general as well as personal associations.
- Colours can be associated with temperature and emotions.

3.3.4.10 *Colour coding*

Colours are often used for colour coding, for example, of objects. This is also used in different signs and symbols. Colour coding may improve attention, learner motivation, and memory. The number of colour codes should be very limited. Colour codes should always be explained. When the number of colour coded items increases, the value of colour as a cue for selecting important information decreases. In videotex, for example, subjects tend to dislike the use of more than four or five colours at the same time. Extensively trained viewers can reliably recognize only about 50 colour codes. It should also be remembered that five to ten percent of men and 0.3 to 0.4 percent of women are red-green colour blind.

A colour-coding process may enable learners to retain critical information and disregard redundant and irrelevant information. An effective and systematic colour code, with a maximum of four to six colours, in a learning material assists the learner in organising and categorising stimuli into meaningful patterns.

3.3.4.11 *Decorative use of colour*

A decorative use of colour should never be mixed with other uses of colour. It must always be clear, and easy to understand when colour is used for decoration and when the use of colour is cognitive. This is also true for the general structure of visuals. Often many visuals are far too complicated, and they would communicate

much better if designers valued simplicity over decoration. This is especially true in electronic documentation which shall be read on a computer screen.

3.3.5 Contrast

In nature, as well as in art, contrast is of major importance for our perception of a message. The contrast is the difference between the brightest and the dimmest parts of a picture or of a text. The contrast should be clear and differentiate image elements from one another. This is regardless of the colour, and regardless of colour-contrast effects.

Visual acuity, our ability to discriminate small objects, peaks at about age 22, then a steady decline starts. This decline is not possible to correct with eye glasses. At about age 40 the tissues of the eyes gets stiffer. This condition, *presbyopia*, or simply “old eyes”, makes it harder for us to shift the distance of our focus. Thus, it is harder to change between reading on a computer screen and reading on paper. For this reason many people need different glasses. Throughout our lives the lenses in our eyes become less transparent. Then we require more contrast between a message and its background to see fine details in images and to read text.

The biggest offence to our eyes is a lack of contrast between message and background. Coloured text on a coloured background is a common example. Different hues may have the same value, and as a result almost no contrast. It is far too common that illustrations in textbooks and in video programs do not have any good contrast. Instead, it is quite often a more or less even shade of grey or sometimes chromatic colours.

Another common problem is the use of too small type. Text must be large enough. Also symbols are often too small. The difference in resolution in different media is very important. A typesetter can produce 10,000, a laser printer 140, and a high resolution computer monitor only ten dots per square millimetre. For people to be able to recognize the colour of an object it should be at least 1.5 millimetre for marks on a paper and six pixels on a computer screen. Thus graphics designed for paper must be simplified for display on computer screens.

3.3.6 Texture

Texture is the visual equivalent of the sense of touch and the feel of an object's surface. From our experience we know that a sweater is “soft”, a steel tube is “hard”, and that a piece of broken glass has a “sharp” edge when we touch it with our fingertips. We can see minute variations in colour and structure of a surface. In our daily lives we have great use of our perception and understanding of texture when we look at various objects in our surroundings. Optical texture serves as a

stand-in for the qualities of actually touching and sensing the real objects. Texture makes objects appear to be smooth or rough, soft or hard, heavy or light, cold or warm, and sharp or flat according to our personal experience of these objects. We can avoid to touch a hot stove. We can be very careful when we have to pick up sharp pieces of broken glass and sharp-pointed and sharp-edged pieces of metal.

Optical texture also works in visuals. In a photograph a sweater and the skin of a baby looks “soft”, a steel tube looks “hard”, and a piece of broken glass looks “sharp”. In a photograph we may recognize and “sense” the hard bronze surface in a sculpture and the soft and warm yarn in a textile. The bronze surface may be perceived as warm, or as cold depending on the content and context in the picture. Texture is very important in the visual arts. In a photograph we can experience the surface of paper, plastics, stone, wood, and many other materials, and remember the feeling from the time when we have actually touched it. To be able to do this the lighting in the picture and the shadows are very important. Lack of detail communicates a smooth texture. In a painting clear and distinct brush strokes contribute to an impression of three-dimensional texture. Texture adds realism in a picture. It also adds an emotional and psychological effect. Many persons react in a positive way to soft and smooth objects, and they find sharp and rough objects repulsive.

3.3.7 Light

Light is essential to the appreciation of three-dimensional images like sculptures. Whether the light is coming from the left or from the right, the top or the bottom, makes a crucial difference in the appearance of the forms. Soft light helps us appreciate subtle undulations. Strong light accentuates details on the surface. The word photography has its origin in Greek and means “writing with light.” Drawers as well as painters and photographers make use of various lighting conditions, light, shadows, and darkness to create perceptions of volume in two-dimensional pictures. A person or an object depicted in hard or soft light will be perceived differently. The physicist defines light as visible radiant energy. Actually, light is invisible. We can see it only at its source and when reflected. Light has outer as well as inner orientation functions.

Light will articulate our *outer orientation* with respect to space, texture, and time. Without shadows we can make out the basic contour of an object. Shadows define space. The *attached shadow* is on the actual object. It helps to reveal the basic form and dimensions of that object. The *cast shadow* (Figure 3.13) is frequently observed as being independent of the object that caused it. Depending on the angle of the light source, the cast shadow may reveal the basic shape and location of the object that caused it. The surface appears to be curved when the light falls off gradually.



Figure 3.13 Cast shadows. The pale light from the rising sun gives distinct cast shadows on the ground.

A highly directional (hard) light produces fast fall-off. Thus, a curved surface is emphasized. A highly diffused and non-directional (soft) light produces slow fall-out. Prominent cast shadows caused by hard light from a low angle emphasize texture. Soft light, on the other hand, de-emphasizes texture. Thus, both hard and soft light may be used successfully for spatial and tactile orientation, for example, in portrait photography. In daylight the background is usually bright. The cast shadows are very pronounced and the fall-off is fast. In a night time scene the background is dark. The lighting from various light sources is highly selective. Shadows are prominent. The human eye is attracted to bright areas in a visual. This can be used for emphasis and directing attention in a visual. Bright areas tend to be perceived in front of other picture elements, while dark areas tend to be perceived as receding.

As well as light can articulate space, texture, and time, it can also articulate *inner orientation* functions. In motion picture and TV production, light, especially combined with music and sound effects, can evoke a great variety of specific feelings and emotions within us. Minor position changes of principal light sources may have drastic effects on our perception of mood and atmosphere. For example, a face lighted from below may appear unusual, ghostly, and brutal.

3.3.8 Composition

Here composition is discussed with respect to the individual picture, and not for page composition. We need to organize picture elements within an individual picture and find a balance according to aesthetic principles. Usually, simple figures are more salient than complex ones.

3.3.8.1 *Organization*

Usually a visual shall deal with only one concept, and only provide the information that is necessary for the audience to understand the content. The elements in a visual may be arranged in a pattern that is clear and easy for the reader to comprehend. Organization provides a pattern that facilitates learning. By organizing the graphic elements it is possible to direct the eye movements within the picture. Perceptually, we group things on the basis of similarity and distinguish between things on the basis of disparity. Certain stimuli, such as contour lines, unusual colours, or graphical symbols, are accentuated in perception while others, such as uniform areas, are not. Background colours, shades, frames, and typography, can be used to achieve unity. In this way the picture elements are viewed as a whole, as a unit. Organizing a message can make perception much easier and learning more efficient. The visual should have a moderate degree of complexity. Complexity without order produces confusion, and order without complexity produces boredom. Differences in texture and grain may help organizing information.

Direction, position, and orientation of objects are essential parts in organizing information. Many confusing results may occur if used improperly. Position is one of the strongest factors in attracting attention. The more informative parts of a visual attract more eye fixations than the less informative parts. The information should be organized in such a way that the most important information is most prominent.

To serve their function, schematic pictures must be well organized. Since they cannot contain too many picture elements, it is better to divide the information into several different pictures than to allow one schematic picture to be overloaded. Do not use a schematic picture when a simple list will do. There must be sufficient distance between different elements in a picture, at least a few millimetres. If it may be necessary to show several (= an undefined number) similar picture elements in one schematic picture, for example, several documents, several processes or several samples of particular hardware. To save space, the picture elements can be partly superimposed on one another, but it is wise to limit these elements to two or three at the most, to keep the schematic picture from being overloaded. To aid comprehension, a pair of picture elements that are connected to each other can constitute a symbol that means “several documents”, for example, or “several processes”.

To avoid misunderstandings, we should not use shadows behind picture elements to provide aesthetic spice or a false third dimension. If necessary, the number of picture elements can be shown as a digit on the actual symbol. The idea of “several” picture elements can also be expressed simply by giving the symbol a plural name. We can place picture elements at different *levels* in a schematic picture.

3.3.8.2 *Balance in pictures*

In nature balance is normal. A visual should usually display the best possible balance. Elements of the visual should fit together in an aesthetic and harmonious relationship in a manner which is interesting but not distracting. Man has an intuitive sense of balance. When a single element is too large or too small, too light or too dark, too prominent or too indistinct, the entire picture will suffer. A composition is balanced when the visual weight (size + value) of design elements on either side of the centre of balance is approximately equal. As with physical balance, lighter elements can balance heavier elements if their size or value is increased, or if they are moved farther away from the centre of balance. It is also possible to move the heavier elements closer to the centre of balance. Imbalance creates an uncomfortable feeling in the reader and should be avoided. Imbalance, however, can be used to attract attention within a picture or within a material. Unexpected, irregular, and unstable design will attract attention. As soon as instability is introduced in a picture the result is a provocative visual expression. The eye will struggle to analyse the relationships and the balance within the picture. Balance could be formal with total symmetry or informal. Formal balance is felt to be static. Informal balance contributes to a feeling of dynamism. However, the mind needs stimulation and surprise. Contrast and imbalance in a picture can dramatize an image and attract attention. Several artists use a visual strategy, such as combinations of dark and bright, large and small, round and square, to sharpen meaning.

The visual should only have a few *centres of interest*, preferably only one at or near the visual’s optical centre just above and to the left of its geometric centre or otherwise in the upper third of the visual. Thus the visual has unity. The most important elements of the visual may be emphasized to enhance perception. According to the “rule of thirds” the centre of interest may be selected at any one of the four points where equidistant vertical and horizontal lines divide a picture in three parts.

3.3.9 Pictorial perspectives

We have two eyes, and we naturally see in three dimensions rather than in one or in two dimensions. The illusion of depth is created when our brains interpret the slightly different views from our two eyes. We have to distinguish between an

optical and a perceptual reality. Optical reality is governed by geometry and is only visual. However, perceptual reality is governed by *object constancy* and combines what we already know about the subject with what we can see, hear, smell, etc. Central perspective is the graphic equivalent of optical reality and is a rather recent perceptual acquisition developed in the early Renaissance by artists who learned to see form and space in a new way.

Perception of depth is related to volume, weight, and mass. Spatial perception is not the perception of space as such but of the learned meaning of the relationship between different objects seen in space. The perception of depth is related to the relative size of known objects, to lighting conditions, to illumination and shadows, to judicious croppings, to linear perspective, to change of line weight, to texture gradients in the picture, to upward angular location of grounded objects, to inter-position and overlap of picture elements, and to filled and empty space. Image elements conveying a sense of depth should be clear and easy to comprehend. Depth perception is also based on the different colours' of varying wavelengths.

3.3.9.1 *Realistic linear perspectives*

In a *realistic linear perspective*, objects are conceived as being placed behind a picture plane onto which straight beams of light are projected. Linear perspectives are based on the idea that an object appears to grow larger in size as the distance between it and the observer decreases. A view along a road with identical trees will produce the familiar convergence of lines. The trees appear to be successively smaller. This is sometimes called *diminishing perspective*.

In the western world the *position* in a picture of a known object, like a car, with a known actual size will give us a depth cue. Regardless of distance there is a constancy in the perception of the size of known objects. (As previously noted this is called size constancy.) The perception of distance is related to the perceived size, and the perception of size is reciprocally related to the perceived distance. The perception of size is influenced by colour and grey scale. Open and light forms are perceived as being larger than closed and darker forms of the same shape. The perception of size is very much influenced by contextual variables. Large cannot exist without small.

A linear perspective uses the principle that, as parallel lines recede, they seem to converge, or meet at a distant point. In a view of a long straight road, the sides and telegraph wires appear to meet at a vanishing point on the horizon even though they are parallel in reality. An artist represents linear perspective by moving all lines on the canvas toward a vanishing point on the horizon line. The eye level of the observer determines the location of the horizon line. If all lines vanish in a single point, the picture is in a *one-point perspective* (Figure 3.14). This is also called *central perspective* and *Renaissance perspective*.



Figure 3.14 Central perspective. This print by Dürer (1471–1528) shows how an artist looked at his model through a glass with a square grid and worked on a surface with a similar grid.

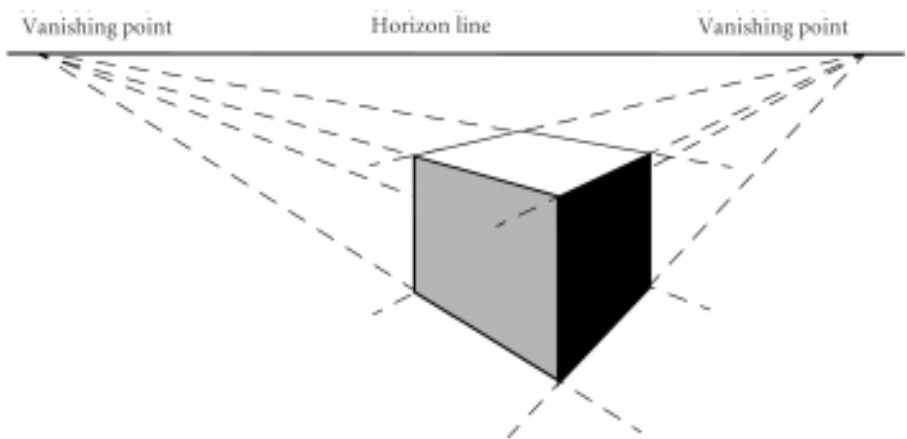


Figure 3.15 Two-point perspective. This box is drawn in a two-point perspective, with two vanishing points on the horizon line.

Lines that vanish in two directions to two different vanishing points produce a *two-point perspective*. (Figure 3.15). This is also called *angular perspective* and *oblique perspective*. All linear perspectives have exact formulas with many and complicated rules (Figure 3.16).

In schematic pictures a cast shadow, or a drop shadow, behind two edges of a picture may create a perception of three dimensions and depth. If this is done correctly, the picture seems to be floating a little bit above the page. However, *cast shadows* may create a lot of confusion and they may actually impair legibility and communication. It is especially confusing when the shadows are of different sizes, implying a three-dimensionality and a perspective that neither exist nor need to exist (Figure 3.17). Sometimes shadows may fall in different directions in the same



Figure 3.16 Cubes. The first cube (1) has a correct perspective. The other four cubes contain common perspective errors. The second cube is too wide. The third cube is too tall. The fourth cube is out of convergence, and the fifth cube is out of proportion.

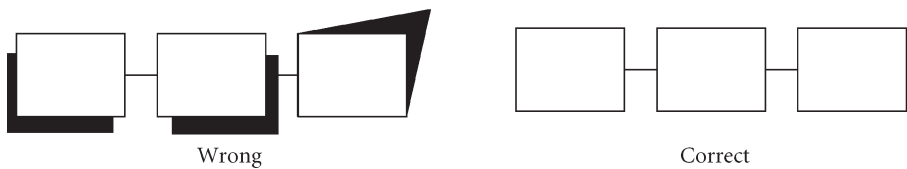


Figure 3.17 Shadows. We should avoid using drop shadows behind picture elements in schematic pictures. They impair reading of the actual information.

picture. Avoid shadows or any other picture elements that complicate the visual and make it more difficult to read and to comprehend.

In a *reversed linear perspective*, the foreground seems to be smaller than the background. The straight lines converge in the direction of the viewer. This perspective is frequent in Japanese and Chinese art, which seeks to draw the viewer into the picture to take an active part in the events depicted. In early Asian art there are no shadows. It is conceivable that a reversed line perspective can be either a reversed parallel perspective or a reversed central perspective.

3.3.9.2 Viewpoints

Photographs often have well defined foregrounds and backgrounds and parts in between. During photography the depth of field is influenced by the distance to the object and the camera aperture. The depth of field can vary from several meters to a few decimetres. By making the foreground sharp and background blurred, interest is directed to the foreground and vice versa. Obviously, it is also possible for an artist to choose depth of field in her or his drawing. Uneasy backgrounds should be avoided in visuals for information and in visuals for learning. Instead balance and harmony should be present in any picture. Often it could be recommended to move in closer on the object and thus avoid uneasy components in the background.

Compared with a normal lens, the narrow field from the telephoto lens makes the representation of an object broader on the film. The wide field provided by a wide angle lens makes the representation of an object narrow on the film. Wide-



Figure 3.18 Eye-level perspective. An example of a picture with an eye-level perspective.

angle lenses have a tendency to enhance linear perspective, while telephoto lenses tend to flatten the perspective. Objects are usually viewed straight from the front and at the same level as the viewer. This “normal picture angle” and the normal way of viewing could be said to represent the *eye-level perspective*, or *normal perspective* (Figure 3.18). This is the least obtrusive angle.

It is easier to comprehend a frontal projection in which the subject is rendered from normal eye level than other projections and angles. The angle of view to a surface that carries converging lines determines the strength of the perspective effect. Too low view fails to read clearly, too high view shows little convergence. In the *bird's-eye perspective*, an object is viewed from a high position; in the *worm's-eye perspective* it is instead viewed from below (at an oblique angle). Several historical paintings of troops and battles show a *military perspective*. Higher than the eye-level perspective, this was perfect to see the different groups of soldiers on the battle-field. Also the *gentleman's perspective* is higher than the eye-level perspective. In visuals that are used for information or instruction we should usually use only one of these vertical level perspectives. As noted earlier there is a constancy in the perception of known objects.

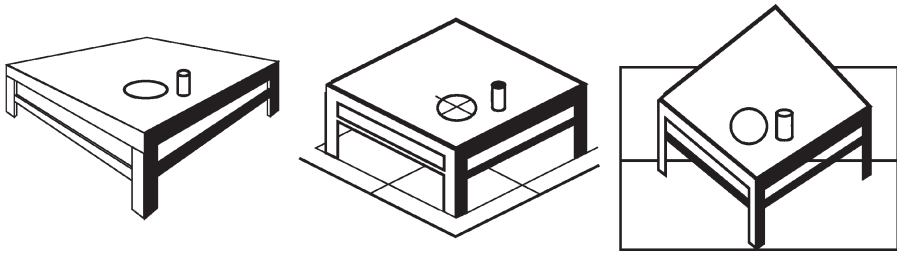


Figure 3.19 Parallel perspective. In the western cultural sphere, we are used to seeing visuals with central perspective, as in the drawing of a table (left). In some cultures it is better to use orthographic views which do not show an object in perspective. The mechanical orthographic drawing of a table (middle) shows proportions exactly. A freehand orthographic drawing, to the right, is not so exact. In parallel perspective (right) parallel lines of an object are parallel in the picture too (adopted from Zimmer and Zimmer 1978; pages 58–59).

3.3.9.3 *Parallel perspective*

In the western cultural sphere, we are used to seeing visuals with one- and two-point perspectives. In some cultures it is better to use *orthographic views*. Mechanical orthographic drawings show proportions accurately with a parallel projection. Parallel lines of an object are parallel in the picture too. This results in three-dimensional pictures with distorted diagonals. When orthographic drawing is traditional in a culture, it is usually drawn freehand, and accuracy is not so important. In some places, only man-made objects and buildings can be drawn orthographically; natural things, including people may not be drawn this way. Zimmer and Zimmer (1978) called orthographic views or orthographic projections non-perspective, but they are sometimes called *parallel perspectives* resulting in *parallel pictures*.

In parallel perspective (Figure 3.19) a *plan* shows a view looking down on an object, a *section* is an image that describes the object as if it is sliced, and an *elevation* is a view looking from any angle describing relationships of verticals and horizontals. Parallel perspective combined with a viewpoint from above is common in traditional Chinese painting. Often foliage is used to crop the parallel lines before they extend far enough to cause a building to appear warped.

3.3.9.4 *Aerial, tonal and colour perspectives*

In a picture of an open landscape, without a natural line perspective, an impression of depth is created by means of an *aerial perspective*, and a *tonal perspective* combined with a *colour perspective*.

The air is never absolutely clear. It is filled with a grey or greyish blue haze, moisture, and dust. This acts like a filter and makes distant objects seem obscure and wrapped in mist and partly hidden. As a consequence, objects viewed

from a long distance are indistinct and pale. This phenomenon is called *aerial perspective*. An artist draws objects nearest to the observer in sharp, heavy lines and bright colours. Sections of a painting that are intentionally made indistinct, without sharp outlines and in neutral colours, will appear as being located far away. They fade away into the distance.

In photography the effect of aerial perspective appears strongly in backlighting. Light tones appear to advance and dark tones appear to recede. A light object against a dark background will normally stand forward, with a strong sense of depth. This phenomenon is called *tonal perspective*.

In a *colour perspective*, colours and hues gradually change from being clear in the picture's foreground into being blurred in its background. Warm-coloured objects appear closer to the viewer than cool-coloured objects. A red or orange object against a green or blue background will have a sense of depth.

In practice, it is difficult to distinguish between aerial perspective, tonal perspective, and colour perspective. These three perspectives are so closely interrelated that they may be regarded as different aspects of the same thing. When we take photographs of objects at a long distance, aerial, tonal, and colour perspectives can be intensified by special lenses and filters.

3.3.9.5 Geometrical perspective

The placement of objects within a picture is important in *geometrical perspective*. This is common among traditional Japanese and Mayan artwork. Here, objects close to the viewer are shown in the lower part of the picture. Objects that are further away from the viewer are shown in the image above the near objects in the lower part. Objects further away may be placed on a vertical line, as steps on a ladder. This kind of geometrical perspective is quite common in children's drawings.

3.3.9.6 Conceptual perspectives

In art of more ancient date, and even in primitive art, there are many examples of perspectives based on meaning, contents, value, and social status. A person's cultural heritage is of great importance for the perception of all conceptual perspectives. The pictures of young children, like many of the paintings from ancient Egypt, India, and pre-Renaissance European art depict objects independently from their surroundings. The pictures show objects as they are *known to be* rather than as they are *seen to be*. Objects and figures are shown in a *multi-view perspective* from all the different views that best present their most characteristic features. In many Egyptian paintings the head and legs of a person are shown in profile, while the eye and torso are shown frontally. This system produces a sense that objects and surroundings have been compressed within a shallow space. Up to the time when Modernism started to question its laws of construction, the realistic linear

perspective was considered the only correct type of perspective in Western art. At the end of the 19th century Paul Cézanne flattened the conventional Renaissance central perspective. Inspired by Pablo Picasso, the cubists broke off completely with the traditional conception of space, and modern art became totally liberated from the time-honoured laws of perspective. Today modern art, oriental art, and illustrations in children's books often use *multi-perspectives* or *multi-view perspectives*.

The significance, the rank, the status, or the value of a depicted object is evident from the size of the object in a picture. Geometrical and mathematical laws are set aside. In Egyptian traditional art, the gods are larger than Pharaoh, who in turn is considerably larger than all his subjects. In several Middle East countries today, the most important person in a group picture is larger in size than the other, less important people. Leaders who happen to be short appear to be "big" leaders since they are the largest in the group. This can be called *value perspective* or *social perspective*. (Compare with *linear perspective*.) Lester (1995) noted that (p. 49):

In a picture of a couple, the man's dominance over the woman often is **signified** by the man being nearer and larger in the frame with his hand resting on or arm wrapped around the woman's shoulder. Over the past two decades, feminist movement has made advertisers and others more sensitive to **nonverbal**, negative stereotypes such as these.

In the European medieval *simultaneous perspective*, time is a spatial dimension in paintings. Several manifestations of the same character or person may be seen in one picture. The interpretation of medieval images are to a large degree determined by the icons, symbols, and allegories used. Several manuals with directions for understanding visual arts have been published. One very important example is "*Iconologia*", written by Cesare Ripa at the end of the sixteenth century, first published in Rome 1993, and later published in several editions. This book was used as a prime source for more than three hundred years by experts when they interpreted classical art. Art historians have learned, and know the language of art. This is, however, not true for people in general. They lack this necessary frame of reference.

During the Baroque era, a special perspective was used in European pictorial art and architecture for the purpose of creating illusionistic effects – the *imaginary perspective*. The artists made individual interpretations of what they saw, and represented these in their paintings. When we convey information, the purpose is the opposite: to present facts as clearly and unambiguously as possible. Modern examples of imaginary perspective are found in pictures created by means of spherical lenses.

A "time-line" is a simple one-dimensional scale with markings for important events. This is often used in graphics and schematic pictures to visualize the rela-

tionships between different historical events. Using a time-line makes it easier for the viewer to see the *time perspective*.

3.3.10 Picture editing

McDougall (1990:ix). explained that picture editing does not deal in absolutes. Taste and judgement are essential because so many variables can influence editing decisions. When we find “good” pictures we can not take for granted that we can use them as they are. There is usually a need for cropping and/or changing the scale of selected pictures. Sometimes it is also possible to manipulate the picture by changing the projection, expanding or compressing the image, changing, adding, deleting, moving, or turning specific picture elements in various ways. *However, in most of these cases we need to get permission from the copyright holder/s to do any manipulation with the pictures.* McDougall (1990:2) provided the following seven questions as an approach to picture editing in visual communication.

1. Is the picture informative; is it interesting?
2. Do camera and darkroom or electronic techniques reinforce the message?
3. What words are needed to strengthen the message?
4. Will cropping improve the content or composition?
5. What is the minimum reproduction size for readability?
6. Does one picture say enough or would two or more be better?
7. How will layout best convey the message?

3.3.10.1 Selection of pictures

Every published picture has been selected, not only once but usually several times. First the picture creator, the photographer, and/or the artist makes a selection of the subject matter. The photographer makes the initial decision as to how much or how little of a situation will be on the film. In any given situation a lot of different pictures may be produced. Then the editor, art director, and/or the designer makes a selection among various pictures in a collection or in an picture archive. In instructional materials a picture should never be used just because it is pretty. Every picture should have some information to convey – if it doesn’t, it should be left out. A number of authors have described different methods for the editing of visuals so as to change their importance and impact. Some important changes which can be made to a visual prior to publication should be mentioned. For example, a picture editor may elect to crop or expand the original picture. Parts of the picture can be deleted, added, altered, moved or changed in shape. The picture can also be enlarged or reduced. A colour can be changed, removed or added. The expressiveness of the picture can be altered by the choice of repro method etc.

There is often a clear difference between the intended and the perceived message (Pettersson 1985). One way to decrease this gap is to supply all pictures with interesting and explaining captions, supporting the intended interpretations (Melin & Pettersson 1991). When too many pictures of different types are used in one single message, some of the pictures may be ignored. There will also be less space for the text. Unfortunately, often archive pictures are used in a way not intended. Sometimes the same pictures appear in several different contexts, which may confuse the readers. As noted before pictures may even have a negative effect. Some illustrations (often without captions) in contemporary textbooks appear to serve no useful purpose whatever. In fact some publishers admit that the two main reasons to use pictures in their books are to (1) *attract buyers* and (2) *increase the prices*.

Interviews with editors, art directors, and designers from major Swedish publishing houses showed that they, in the selection of visuals for reference books and textbooks, often ask themselves questions such as the following (Pettersson 1989: 145):

- Does the picture depict the right thing?
- Is the presentation of the subject satisfactory?
- Is the picture technically acceptable?
- Is the picture aesthetically satisfactory?
- Is the picture “flexible”, i.e., will it work with different formats?
- Will the picture fit into a given area?
- Will the picture fit in with the other pictures on the same page?

In practice, many editors, art directors, and designers find that (1) *procurement time*, (2) *availability*, and (3) *image clarity* are the most important considerations in making their subjective choices among possible visuals. McDougall (1990: 3) recommended three pragmatic tests for judging photo merit in the context of journalism. The tests concern message, aesthetics, and technique.

1. Message

- Does the photo make a clear statement?
- Does the photo meet the ethical standards of responsible journalism?
- Does the photo invade the privacy of its subjects or libel them?

2. Aesthetics

- Is the photo’s composition well-organized and aesthetically appealing?
- Does the composition facilitate the message?

3. Technique

- Do the camera and darkroom techniques enhance the photo’s message?

- Is the photo of press reproduction quality?

Preference for a particular visual format does not necessarily result in increased learning. Yet, in the absence of more substantial data, information based on student preference has a meaningful role to play in affecting learning from information materials and instructional texts. All other things being equal, we should provide formats which are preferred by the viewer, thus making the text more attractive, and hopefully more motivating. Thus selection of artistic style for visual materials should not be an arbitrary decision, but always a conscious one. Although full-colour photographs increase the costs of tradebooks Ramsey (1989) suggested that publishers should increase the number of such books available for primary audiences. Today, however, there are only few informational books for children which meet these criteria. It is actually quite common that various kinds of abstract illustrations are used in textbooks.

3.3.10.2 *Cropping*

A selected photo often needs cropping. By cropping we can eliminate distracting or uninteresting parts of the image. Pictures should always be adjusted to fit into their final context. Image framing makes a clear distinction between image and background. Fading is used to make the image gradually appear on the page. Layout is the integration of text and images, i.e., on an opening in a book. Legends give the reader necessary guidance in understanding the image content.

An original picture can often be improved by removal of irrelevant or distracting elements. Usually pictures can be cropped a little bit from all sides. In practice the photographer always performs some “initial cropping” while taking the actual photograph. When composing or taking a photograph, the photographer sets the boundaries or “frame” of the picture. The same is also true for the artist who makes a “mental cropping” before she/he starts the actual drawing process.

It may be a good idea to take some pictures, for example, from a magazine, and two set-squares cut out of white cardboard and practice cropping. A complicated picture can be cropped and divided into two or more parts, each supplied with their individual legends. Sometimes images can be cropped to non-rectangular shapes like ovals or soft round shapes. Cropping and changing of scale are the most common methods used in picture editing.

3.3.10.3 *Changing scale*

Pictures should always be adjusted to fit into their final context. An image may be scaled up or down. There is an optimum size for each visual. The content remains the same but the chosen scale can influence our perception of it (Figure 3.20).

The size of the visual should be large enough for the image to be legible. If the plane of projection is changed the relations between various parts in the picture

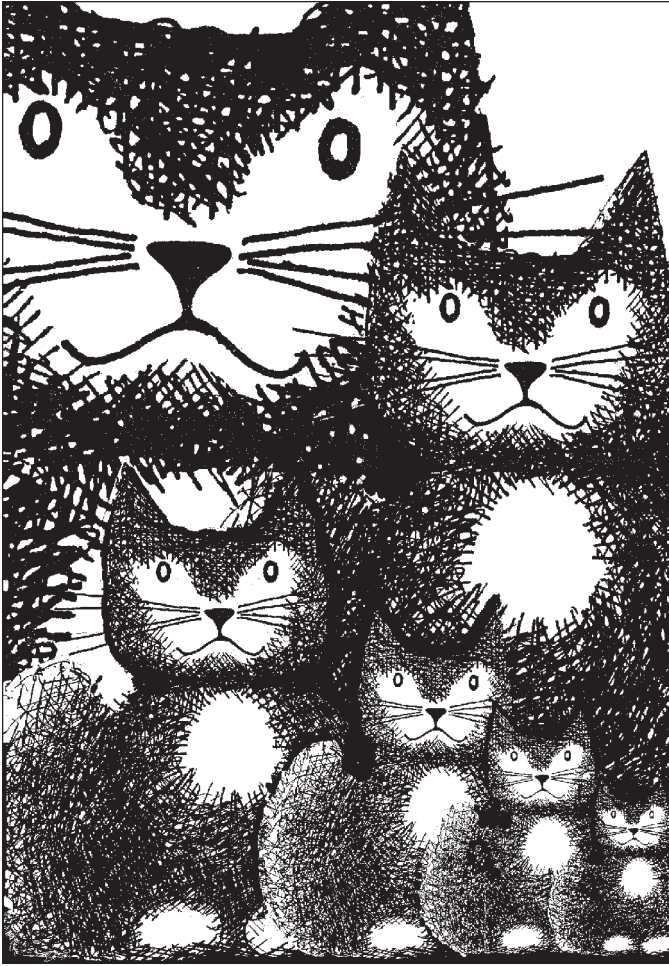


Figure 3.20 Changing scale 1. A line drawing is built up by lines of solid paint. Line drawings may be scaled up and down without any loss of data.

will be influenced. Usually drawings are produced in a larger size than the intended size in the finished product. When scaling down, lines get thinner, tighter, sharper, and more distinct. Drawings look better because lines appear to be more confident. However, small details may disappear. Scaling up has the opposite effect. Lines tend to dissolve and small mistakes become more obvious.

A bit-mapped image, created and stored in a computer, may be scaled (Figure 3.21). However, no new information is added when the image is enlarged and important information is lost when the image is reduced. Thus, it is normally best to create bit-mapped images in the correct sizes.

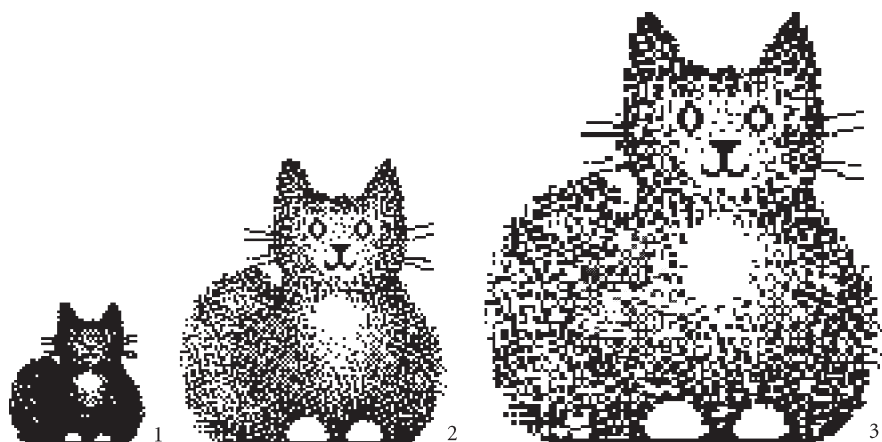


Figure 3.21 Changing scale 2. A bit-mapped image (2), created and stored in a computer may be scaled. However, no new information is added when the image is enlarged (3) and important information is lost when the image is reduced (1). Thus, it is normally best to create bit-mapped images in the correct sizes from the beginning. The small cat will eventually be almost black, and a very large cat will eventually be very light grey.

Another possibility is to create a bit-mapped image in a large size, scale it down with a repro-camera or with a copying machine and then paste it as an original. Object oriented objects may, however, be scaled without loss of quality. Sometimes it might be a good idea to enlarge interesting parts of a picture. Several consecutive enlargements of a specific part will help the reader to understand the detailed structure of an object.

3.3.11 Image manipulation

Modern computer-based graphical systems have great built-in possibilities for manipulating images. However, usually we need to have permission from the copyright owner, and – from an ethical point of view – also from any person in the picture. It seems that photo manipulation has become a common practice for many graphic designers working in advertising and entertainment. However, in news, information design, and instruction design readers and viewers expect pictures and images to represent the truth in a correct way. According to Cifuentes, Myers and McIntosh (1998: 170) the Associated Press has adopted photo manipulation guidelines to prevent dishonest reporting:

- The content of a photograph will never be changed or manipulated.
- Only the established norms of standard photo printing methods such as burning, dodging, black-and-white toning, and cropping are acceptable.

- Retouching is limited to removal of normal scratches and dust spots.
- Serious consideration must always be given in correcting color to ensure honest reproduction of the original.
- Cases of abnormal color or tonality will be clearly stated in the caption.
- Color adjustment should always be minimal.

However, sometimes digital photo manipulation, or digital deception, may enhance a message, and sometimes it should be used for better communication. It is possible to modify an image in several different ways. We can change projection, expand, compress, reduce, delete, modify, add, supplement, move, turn, isolate, or combine various image elements. McDougall (1990:32) noted that converting photos to art is a type of photo theft that picture editors should crack down on. It is far too common that artists transform photographs to artwork for use as illustrations in newspapers and books. To transform a photo into a drawing is not only unethical, it is also often an infringement of copyright. McDougall writes:

The courts have held that a work of art which has been copied from another work which is copyrighted, regardless of alterations, is prima facie evidence of copyright infringement. The courts have also held that copying a work of art in a different medium such as changing a photo into a drawing is still a violation.

3.3.12 Text in pictures

This section distinguishes between texts in pictures and texts as pictures, or pictures of text. Texts within pictures should usually be printed in a sans serif type, such as Helvetica, normal style, and should be as concise as possible. As a rule, texts within a picture element should be centred. Make sure that words or whole texts do not spill over different picture elements, as this will make both the picture and the text difficult to read. When a heading is needed it may be set in nine point bold Helvetica.

Avoid using several lines of text inside a symbol. It is difficult to keep distances consistent inside different symbols, and it is easier to read one short line than several lines. Sometimes it may be a good idea to consider labelling graphics in multiple languages. Type must be large as well as bold enough to see. In verbal presentations, many of the overhead transparencies and slides consist only of text. In written documentation, this type of information should be worked into the body of text instead. Here are a few guidelines and rules-of-thumb for “reader slides” with good legibility.

- Overheads and slides should preferably be horizontally presented.
- The text should be legible to spectators who are sitting at the rear of the room. The minimum size of letters in text should be 6 mm.

- The text should have maximum readability, therefore a linear typeface is preferable, for example: Helvetica 36 p for headings, and 24 p for the body of the text.
- Avoid an excess of text. Use no more than 6 rows of 6 words each in one picture. The distance between lines should consist of the size of the typeface plus 15 to 20% extra white space.
- Edit the text into sections that are easily read.
- Avoid combinations of colours that diminish readability. Some quite good colour combinations are yellow and black, and white and blue. On the other hand, white and yellow, red and green, and red and blue are all very bad combinations.
- Check the spelling.

3.4 Image morphology

Mirror images and other virtual images, created by mirrors, lenses, and other optical systems, can be seen but not “captured” and shown on a screen of any sort. A virtual image is located in a point from which divergent light beams seem to start before they have passed the optical system. Like our inner images, e.g., memories, virtual images lack an obvious physical format. All other kinds of images have a physical format.

An artist or a painter producing a picture may use lead, crayons, India ink, various kinds of paint, paper, canvas, and several other kinds of material in a variety of different combinations. The image is gradually produced by combinations of dots, lines, and areas (Figure 3.22). The actual picture is built up from materials and pigments which, according to intentions, can be completely separated or gradually mixed.

In technical systems the whole motif may be captured at once with a traditional camera, or it may be scanned line by line with a television-camera. Except for the printing of line drawings, all other pictures have to be divided into small elements, picture elements, or pixels, in the technical process of duplication, e.g., in the printing of books or in the broadcasting of television. The image has vertical (y) and horizontal (x) resolution and it has also “depth resolution” (z). An individual pixel may vary with respect to shape, size, position, value, grain, colour, and grey scale.

Computer images are digital. In some image systems the square or rectangular pixel is either white (light) or black (dark) (Figure 3.23). In other systems the pixels can be varied in a grey-scale and/or in a colour range. The number of colours that can be reproduced depends on which computer, which operating system, which

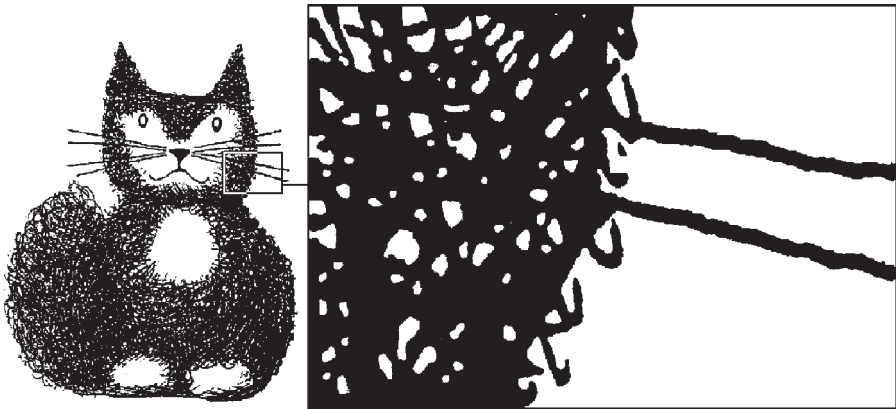


Figure 3.22 Full-tone pictures. A line drawing, with an enlargement to the right. All line-art or “full-tone pictures” are built up by dots, lines, and areas of solid paint. Line drawings, schematic illustrations, maps, and business graphics all belong to this category. Full-tone pictures can be in black-and-white as well as in colour. When colour pictures are printed we need one printing plate for each colour.

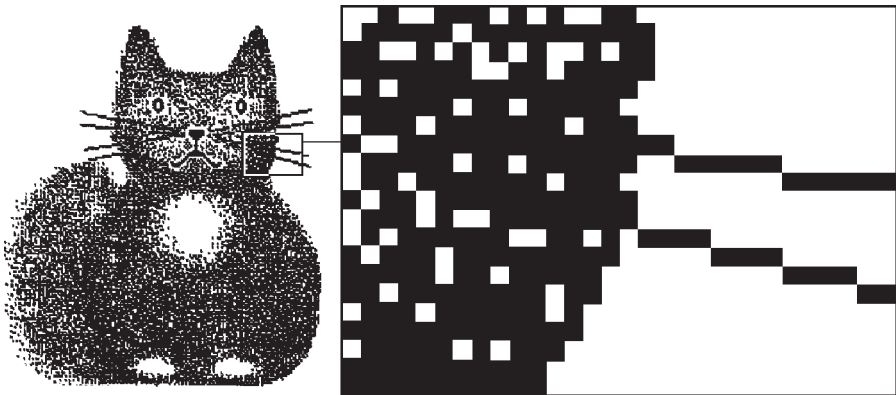


Figure 3.23 Pixels. A bit-mapped picture consists of a large number of small pixels or picture elements, e.g., small squares. These pixels have either a colour (usually black, but they may also be, e.g., green or blue, depending on the design of the screen) or no colour at all. All pixels have the same size. In an image created in the computer with a resolution of 72 d.p.i. it is easy to see the individual pixels. In the enlargement it is easy to see that each pixel is black or white.

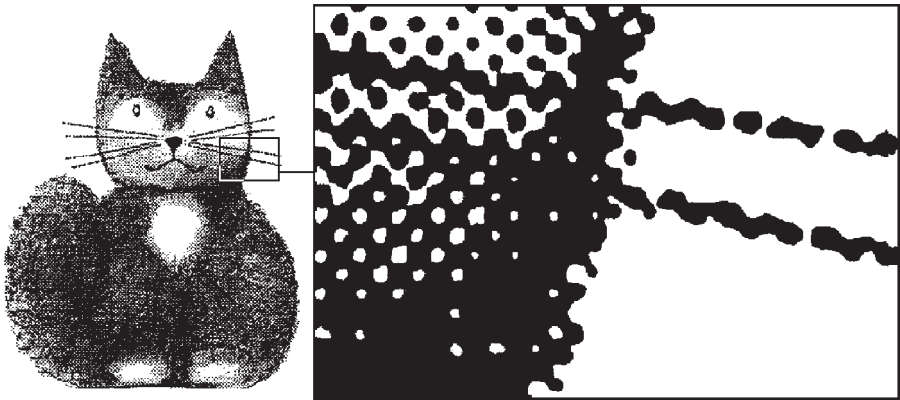


Figure 3.24 Half-tone picture. The photos we see in books and newspapers are really collections of small dots. These printed dots vary in size within the fixed “pixel-area” from nothing or a very small dot to gradually increasing dot-sizes, until the dot covers the complete “pixel-area”. Smaller dots give the impression of light grey areas in the image, and larger dots give the impression of darker tones. The raster pattern is easy to see in the enlargement.

program, and which computer screen is used. Quite often eight bits of information is used for red, green, and blue colours, respectively, and eight bits for text and graphical effects. Each colour can be stored in 256 levels. In total it is possible to create 16 millions of nuances in the image. Pixels are always small compared to the screen. The more pixels within a given area the better the sharpness and the more details in the system. Pixels in large systems can actually be much larger than whole screens in smaller systems.

The photos we see in books and newspapers are really collections of small dots (Figure 3.24). These printed dots vary in size within the fixed “pixel-area” from nothing or a very small dot to gradually increasing dot-sizes, until the dot covers the complete “pixel-area”. Smaller dots give the impression of light grey areas in the image, and larger dots give the impression of darker tones. Thus, it is possible to reproduce photos, drawings, and other originals with (perceived) scales of grey. (Note that half-tone rasters will only simulate grey. This is possible due to the imperfection of our vision. The only way to really achieve a grey hue is to print the image with grey printing ink.)

In newspaper production, rasters with a density of 50 to 65 lines per inch may be used in the pre-press process. For book production, rasters with a density of 100 to 133 lines, or more, per inch may be used (Figure 3.25). Higher-quality printing allows half-tone rasters of up to 300 lines per inch, resulting in images with dots so small that you can hardly see them at all. The films that are used to make printing plates may be produced using photo-typesetting machines, working with resolu-

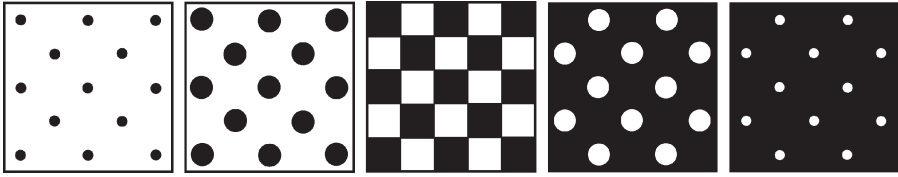


Figure 3.25 Rasters. Examples of five “raster patterns” with increasing size of the individual raster dots (from less than 10% to more than 90% of black.)

tions of 600 lines per inch for the newspaper plates and 1,200 lines per inch for the book plates. An image, say a two by two inch portrait, may be printed with 10,000 dots in a newspaper and 40,000 dots in a book. A large outdoor placard printed with low resolution may be at least one thousand times larger than the same advertisement printed with high resolution in a magazine. Both images may have an equal number of pixels.

Images in colour have to be separated using different colour filters. This can be done photographically with a reproduction camera (analog technology) or electronically with a scanner (digital technology). Images in colour are separated into four different half-tone films: blue, yellow, red, and black. A printing plate is generated from each film. The picture is then printed in each colour, resulting in a “four-colour-process” visual. The easiest way to understand printed dots is to examine a printed picture. In a newspaper, the printed dots can be seen with the aid of a magnifying glass. On outdoor advertisements, and posters we can often see the individual printed dots even without a magnifying glass if we look at it from a normal reading distance.

Normally these pixels are very small. At normal reading distance they can hardly be seen. In fact *an image with “good quality” must have a resolution that is better than that of our own vision.* In real life, nature and all kinds of objects have got an infinite number of colour nuances and shades of gray. Our perception system can handle enormous quantities of information under very different conditions. At any given moment, the eye may contain 2,500,000 bits of information. We can see one detail that is a 1,000 times brighter or darker than another detail. For 35 movie film this range of contrast is 100 and for television it is only 10–20. Yet our eyes are by no means “perfect” optical systems. The eye has inertia. It takes time to read an image. This inertia enables us to see the motion in the stills which comprise movie film and television. Movie film usually uses 24 pictures and PAL-television 25 images per second. This is just below the so called “flicker threshold” which lies at about 27–28 images per second. At higher picture frequency the eye can no longer keep up. NTSC-television uses 30 images per second and thus gives a more stable television-image than PAL-television.

Take a close look at a colour-television-image (about an arm's length distance). In the very centre of the gaze you are able clearly to see the small red, green and blue dots or bars (depending on the model) making up the television-image. This clear oval or circular area, between a dime and a quarter in size, is falling on your foveas. It will jump around as you move your eyes over the image and make four to six eye fixations per second. At normal television-viewing distance all the small dots blend together and we may perceive the image as "rather good" or "good". More pixels are needed to make a really good television-image. The maximum resolution is the same as the distance between two cones in the retina with one non-activated cone in-between. This correspond to some 200 pixels per millimetre (5,000 pixels per inch) at normal reading distance. The necessary number and size of individual pixels will be defined by:

- The size of the object depicted
- The size of the image
- The viewing distance
- The image content
- The actual material carrying the image (paper, film, glass, etc.)

Close viewing distances require the images to be divided into many small pixels. For long viewing distances it is enough with fewer and larger pixels. And pixels really vary in size, and they also represent very different parts of reality. Some examples will be given here to illustrate this.

The first American Landsat-satellite was sent up in 1972. Landsat-1 registered green, red and two bands near infra-red. Pictures cover 185x185 kilometres on earth. Each pixel represents 80x80 metres, that is 6,400 square metres. Landsat-1 was a great success and was followed by Landsat-2 in January 1975 and by Landsat-3 in March 1978. Since 1982, the Landsat-satellites produce images with a resolution of 30 metres. Each pixel has been reduced to 900 square metres. In February 1986, the European SPOT-satellite was launched into orbit. The SPOT-satellite delivers images with 20 metre resolution in colour and 10 metre resolution in black and white. Now the pixels were reduced to 400 and 100 square metres respectively. Usually SPOT-pictures depict 60x60 kilometres of the surface of the ground. Such a black and white "scene" has got 6,000 lines with 6,000 pixels each, that is a total of 36 million pixels. At Esrange, the premises of the Swedish Space Corporation in Kiruna, in northern Sweden, a quarter of a million SPOT-pictures are received every year. With pictures like this it is possible to produce several kinds of maps for use e.g in agriculture and forestry. Certain military satellites, "spy-satellites", are suggested to produce pictures with a resolution of only a few decimetres. Then it is possible to distinguish individual people for example on board a ship. When a SPOT-scene and a photographic portrait of a person are printed with the same

resolution as full pages in the same book, a pixel in the first image represents a portion of reality that is one million times larger than the area represented by a pixel in the second image. At the 1980 Olympic summer games in Moscow some 3,000 Russian soldiers holding square textile fabrics in different colours produced several different images. The image of Mischa, the Russian bear, became a symbol of the games. When we see the tracks and trails left by animals in snow or in soft mud these “visuals” may tell you a lot about the animals and their activities. Skilled hunters will “read” these visuals as we read pictures in a book. Such a visual may consist of just a few pixels. A single foot-print from the hoof of a horse is in fact a one-pixel-picture. Take a shower, a bath or a foot-bath, then walk across the floor. Your foot-prints will be pictures consisting of just a few pixels.

The Jumbotron, the largest video-screen in the world was 25x40 metres, equivalent to a ten-storey building when it was presented in Japan in 1985. The Jumbotron-image, which could be seen by more than 50,000 people at the same time, consisted of 150,000 picture elements. Each picture element was a 8x4.5 centimetre TRINI-LITE cell with a blue, a green and a red section. A computer system was used to control all the different pixels individually.

For a few thousand years artists have produced mosaics as decorations on floors, walls and roofs. Mosaics consist of thousands of small pieces, usually of glass or marble in different colours. Each piece is carefully put into a soft foundation which then hardens. The large mosaics in the cathedral of St. Peter in Rome and in many other churches are seen as actual paintings. One has to get really close to the images to see the individual pieces of glass-pixels. For thousands of years man have produced images on various textiles such as pieces of embroidery, pieces of knittings, pieces of crochet works, pieces of needlework, woven fabric tissues and tapestry. Different kinds of yarns and threads have been used to make stitches, seams and knots. In a textile picture these stitches, seams and knots are the pixels.

In the production of enamel signs, which were quite usual at the last turn of the century, it was necessary to use very stylized images. To be able to produce templates that would last when excess paint was brushed off fine details could not be used. The result was a unique and distinct sharpness which we still can admire. Another example of picture elements is intarsia, decorative wood works. Each wooden piece is a pixel. All are different with respect to shape, size, colour and placement.

CHAPTER 4

Graphic design

Based on the conventions of typography and research into reading and perception, this chapter presents a number of guidelines with regard to typography and layout. The legibility of a graphical message is determined by the design of its text and pictures, as well as by their clarity. Good graphic design is simple and direct.

Advertisements in newspapers, and advertising flyers, must be designed so that they will be noticed as easily as possible. Therefore, it is important to choose a graphical form that arouses interest. Here, unusual typefaces can be useful. Here, the graphical form should stimulate attention, entice the reader to look at the pictures and begin reading the text. Since there are over 60,000 different typefaces (with still more being introduced), it is easy to combine them in many ways (Mijksenaar 1997). Most of these typefaces are, however, limited in their usefulness.

In my view the graphical form should basically be simple and “transparent” in information design. It should not arouse any special interest or attention for its own part. Here the graphical form should not be too exciting or provocative, nor should it be patently dull.

Often graphic design is thought of with regard to the print medium, but it is also used in several other media. Hightower (1989:7) noted that graphic design is a ubiquitous presence in our daily lives that can engage and inform us or simply add to the visual morass of contemporary culture. Important and unimportant messages are graphically communicated throughout the day.

According to Friedman (1989:10) the taint of commerce has relegated graphic design to the status of a “second class” discipline in the academic realm. A generally accepted view is that graphic design may be described as the art and craft of bringing a functional, aesthetic, and organized structure to groups of diverse elements. These elements may be headings, texts, pictures, captions, tables, and sometimes even sounds and motion in motion pictures, on television, and on computers.

Modern *visual graphic design* has its roots in the rational, functional aesthetics that evolved in traditional graphic design over the centuries for the print media, and are now used in *industrial design*, as well as in *architecture*. In contrast to traditional graphic design, now the most fundamental design technique is *reduction*. Today an “elegant design” must be reduced to its essential elements and each element reduced to its essential form (Mullet & Sano 1995:38). Good design is sim-

ple, bold, and direct. It ensures that significant design elements will be noticed by removing insignificant elements wherever possible. Good design provides rational, functional aesthetics, as well as effective and efficient layouts for all media.

4.1 Information aesthetics

Throughout history all cultures have produced *art*; musical, verbal as well as visual art. *Fine arts* is often assumed to mean the visual arts, like architecture, painting, and sculpture. To create, to recognise and generate *order*, seems to be universal impulses and activities. One of the earliest human artistic acts was to shape tools more than was functionally necessary. Paleolithic Neanderthal man decorated their spearheads. Some theorists argue that the origin of human creativity can be found in early crafts of tools and weapons. Throughout history art has been produced for different reasons, such as religious devotion, commemoration, adornment, and for personal expression. Art has also been created on many scales, from huge buildings, large murals and paintings to small jewellery. 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. In painting space is an illusion. Here an indication of three dimensions in two is rendered by conventions. However, the conventions vary a great deal in different periods and in different places. In many situations it is not possible to understand the meaning of art. To some degree, the physical materials used by artists influence the properties of the resulting artwork. As an example, a fresco painting on a wall has different visual properties from an oil painting on canvas.

Aesthetics is usually regarded as a branch of philosophy, along with logic, metaphysics, epistemology, and ethics. Aesthetics is the youngest branch of philosophy with its own name. The term aesthetics was introduced in 1735 by Alexander Gottlieb Baumgarten, a leading German philosopher. However, a large number of philosophers, from Plato to the present day have discussed “the philosophy of art”. Aesthetics aims to establish the *general principles of art and beauty*. Aestheticians study all the arts, from all countries, and from all periods of history, in relation to their physical, social, and cultural environments. In order to do this aestheticians try to organise knowledge of art in systematic ways. In *The New Websters Dictionary and Thesaurus* (Ottenheimer 1991) the word *aesthetics* is defined (p. 17) as: “the laws and principles determining the beautiful in nature, art, taste, etc.”

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 advertis-

ing” 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 lithographies, 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.

Aestheticians try to understand the arts in broad and fundamental ways. 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”. Aesthetics implies a hierarchical judgement in which the elements of any given composition, and their organisation are considered more or less appealing to the senses by virtue of their ability to call up a higher emotional, intellectual, or moral appreciation in people. Aesthetics is often divided into two areas, (1) the philosophy of beauty, and (2) the philosophy of art. These two philosophies are essentially different.

4.1.1 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 beautiful. However, there is much more to art than beauty. In fact in many situations art may actually have little, or nothing at all to do with beauty. Until the 18th century, scholars regarded the study of beauty as the whole or as the main problem of aesthetics. Since that time, aestheticians have devoted more efforts to the philosophy of art than to the philosophy 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 which 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 the various 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 firm rules about what artists should create and what people should like. During the past centuries many of these rules have been abandoned. Psychological pleasure derived from an art work comes from the similarity of the artist's values and the sense of life to one's own values. Admiration of an art work 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 art work, but can at the same time admire the artist's skill or style.

In *The New Webster's Dictionary and Thesaurus* (Ottenheimer 1991) the word *beauty* is defined (p. 44) as: "the inherent quality in an object of pleasing the eye, ear, or mind; a particular grace or excellence; a beautiful woman; a fine specimen." Philosophers have made many unsuccessful attempts to define beauty. In the 18th century philosophers agreed that beauty could not be defined in terms of the qualities shared by all beautiful objects. Three theories concerning the nature of beauty are (1) the formal theory, (2) the emotional theory, and (3) the relational theory. The *formal theory* locates beauty in the qualities of objects. According to this theory an object may be considered beautiful when it has integrity, unity, proportion, and splendour. However, the *emotional theory* identifies beauty with the mental responses of the audience; the listeners and the viewers, and their aesthetic experiences. According to the *relational theory* beauty includes aspects from the other two beauty theories.

4.1.2 Philosophy of art

The philosophy of art includes traditional, philosophical theories of art: for example, Platonic, Aristotelian, rationalist, empiricist, idealist, Marxist, phenomenological, existentialist, feminist, and postmodernist aesthetics theories. Such theoretical positions inform, but are also tested by, critical and interpretative articles about particular types or examples of artworks. The information designer may focus his or her 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. The aestheticians discuss the philosophy of art from various perspectives, such as: the metaphysics of art, experiences of art, interpretations of art, production of art, and definitions of art.

Aestheticians ask questions of this kind: (1) What kind of entity is a work of art? (2) What access does art give people to reality? Works of art may be physical objects, such as sculptures. However, not all works of art are physical objects. A dance and a theatrical performance may be as aesthetically relevant as any physical object. A flat painting can represent spatial depth and fast movements. What the

painting represents often seems more aesthetically relevant than its physical dimensions. Some philosophers have concluded that works of art represent mental entities, such as visions and dreams. Other philosophers have noticed that artists may express their attitudes, emotions, and personality traits in their art, and have concluded that art works belong in a category with non-verbal communications rather than with physical objects. Still other philosophers argue that works of art exist only in the minds of their creators and in the minds of their audiences. The question whether art can provide knowledge of, or insight into, reality is as old as philosophy itself. Plato argued that art has the power to represent only the appearances of reality. The opposite position is common among modern philosophers, artists, and critics. Since art can reflect powerfully emotional values to the beholder, art can be loved, appreciated, and enjoyed for those values. The art work itself, however, is an extension of the artist and thus can never be spiritually possessed or owned by anyone else, even though the physical ownership and copyrights can be transferred and sold.

It is a common belief that a person's response to art is a mystical experience that has no basis in reality and serves no practical purpose. But the opposite may very well be true. A positive response to art may reflect a person's most important values. Another common belief is that art is entirely subjective and cannot be evaluated on an objective basis. Discussions about how people experience art have been dominated by theories devised in the 18th century. Some philosophers still think of the typical experience of art as contemplative and disinterested, different from everyday concerns. A few modern aestheticians have stressed the continuity between aesthetic experience and everyday experience. The social sciences, such as anthropology, archaeology, and sociology, help aesthetics researchers explain the forms that art has taken in various cultures, and how the arts are related to religion, science, government, and economic activities. Recent theories of post-structuralism and interpretation theory propose strategies of critical evaluation that incorporate multiple viewpoints and accept a basic indeterminacy in meaning.

In aesthetics one area of study is concerned with the study of the interpretations of art, how people use, enjoy, and criticise art. What happens in the minds of people when they look at paintings, listen to music, or read poetry. Knowledge of psychology helps the aestheticians to understand how people act, desire, feel, hear, imagine, learn, see, and think, in relation to art and aesthetic experiences. One question is whether evaluative judgements can be backed by strictly deductive reasoning based on premises descriptive of the artworks. According to some opinions judgments are merely expressions of personal preferences. Thus these opinions cannot be considered true or false. Another basic question is whether conflicts

over interpretations of a work of art can be settled by facts about the work, or whether more than one interpretation of a specific work is possible or not.

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.

Philosophers have made many unsuccessful attempts to define art. Usually definitions of art aim at establishing a set of characteristics applicable to all kinds of fine arts, as well as the differences that set them apart. After some hundreds of years of discussions aestheticians have not yet agreed upon a definition of art. Some say that it is impossible to define art. *Art criticism* may be defined as the process of judging the aesthetic qualities of visual art, mainly painting, sculpture, and architecture, but also craft. This has become a specialised field, but judgements about works of art have appeared since ancient times. In the Western world, reflection on art began with the philosophers of ancient Greece. Plato discussed *proportion* as the source of beauty, and *imitation*, as the primary mode of art. Aristotle identified different kinds of *imitation*. Xenocrates wrote about painting and sculpture, and the ideal *synthesis of proportion and imitation*.

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 which 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.

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

to the aesthetic of any design is more important than simply making things look pretty. When the Apple Macintosh first appeared on the market people in the business world assumed that aesthetics have no useful function beyond making something look nice. Business people were accustomed to the IBM PC. They wrongly assumed that the aesthetically pleasing Macintosh interface could not possibly be as useful as the less attractive text-based interface of the PC. However, aesthetic properties of a design makes the product more personal, more intimate, and more special. It may be an advantage if information materials look good. However, in my view functional properties are always more important than aesthetic properties in information design.

4.1.3 Harmony and proportion

Certain relationships between various design elements look good when they are placed together. Other design elements may look ugly. The term *harmony* may be used in all design disciplines to mean that the design decisions, and the design elements fit well together. Graphic designers, information designers, instruction designers and persuasive designers often use the term in discussions on typography and layout.

Basically *proportion* is a mathematical concept. However, the concept *aesthetic proportion* is very much subjective. We may all have different ideas of what is beautiful. The concept aesthetic proportion goes back to the early Greeks. Many archaeological buildings and sites are masterpieces of classical proportion, harmony, and balance. The Greeks tested various dimensions and ratios in their architecture. They developed the concepts of the *golden section*, the *golden ratio*, the *golden mean*, and the *golden rectangle*, in order to express their aesthetic ideals.

A *golden section* is a line segment that has been divided into two parts in such a way that the ratio of the longer part (b) to the shorter part (a) is equal to the ratio of the entire segment (a + b) to the longer part (b). This can be written as $b/a = (a + b)/b$. The ratio between the two segments is *one to the square root of two*, or 1:1.41, approximately equal to 1.618, or 3:5, 5:8, 8:13, 13:21, 21:34, etc. This ratio is called the golden ratio. For practical use the ratio is standardized at 3:5 (Figure 4.1).



Figure 4.1 A golden section is a line segment that has been divided into two parts in such a way that the ratio of the longer part (b) to the shorter part (a) is equal to the ratio of the entire segment (a + b) to the longer part (b).



Figure 4.2 Golden rectangles. An interesting result of the golden rectangle’s proportions (left) is that if we draw a square (white) inside the rectangle using the short side of the rectangle as the side of the square, the remaining area (black) will also be a golden rectangle. This process can be repeated indefinitely.

The concept of a golden section is of historical importance in aesthetics, architecture, and art. It has often been stated that a form, including the human body, is most pleasing when its parts divide it in golden sections.

A related concept is the *golden rectangle*, which is a rectangle that has adjacent sides with lengths in the golden ratio. An interesting result of the golden rectangle’s proportions is that if we draw a square inside the rectangle using the short side of the rectangle as the side of the square, the remaining area will also be a golden rectangle (Figure 4.2). This process can be repeated indefinitely.

A golden rectangle has proportions which the ancient Greeks felt were the most aesthetically pleasing of all rectangles. The golden rectangle appears in many famous buildings, works of art, etc. It is especially prevalent in architecture and in renaissance art. Television as well as film screens are horizontally oriented, since we basically experience the world on a horizontal, rather than a vertical, plane. When HDTV was developed it was found that people preferred the aspect ratio of 3 x 5 (the golden rectangle) or 9 x 16 (1:1.778) over the traditional 3 x 4 (1:1.333) ratio of the current television systems.

4.2 Typography

Type is a letter, a number, or any other character used in printing. The words we need in books and other graphical media use type. It may be hard to imagine how people lived 500 years ago without type. At that time all texts were copied by hand or printed from wood blocks. Today printers use thousands of type styles. A type style makes somewhat the same impression on the reader that a speaker’s voice makes on the listener. Some type may suggest strength. Others may suggest delicacy.

4.2.1 Typefaces

Lenze (1991) noted that private documents may invite the use of ornate and stylish looking fonts. Professional documents, however, require maximum legibility (Tin-

ker 1963; Benson 1985; Pettersson 1989). Type can be created in a variety of styles. A change in type style can signal a change of purpose, a new section, or another degree of importance. Typographical techniques can alert learners to such things as main ideas, important concepts, rules, sections, subsections, and more. However, multiple type styles on a page tend to be confusing rather than facilitating. The decision of which font or which fonts to use should rest largely on the purpose and audience of the document (Benson 1985).

Systems for desktop publishing are now common. Easy to handle software gives the layman the opportunity to combine verbal and visual messages. This technological revolution enables us to do anything we have in mind to do on a page or on a screen. We are no longer restricted by the mechanical processes of typesetting and makeup. Unfortunately, most desktop publishers know little about typography, graphic design, and information design.

With the new systems it is almost too easy to manipulate a text and make use of all the possibilities to change the appearance of a page. It is far too easy to create confusion or even a complete mess-up. As White (1987) put it: "The distinguished art and craft of typography developed over centuries by sensitive craftsmen/artists cannot be handed over to an indifferent typist keyboarding a machine (however marvellous the technology) with results of equal excellence and stature. The reader feels the difference in terms of the piece's ease of reading, charm, and comfort." It is wrong economy to cut back on investment in quality, believing the readers won't know the difference. Winn (1993) noted that in text, attention is drawn to words or passages that stand in contrast to the rest of the body of the text. To encourage readers to pay attention to relevant information, text designers should help the reader to control his or her cognitive processes during learning (Mayer 1993). To achieve optimum legibility it is known that:

- Common typefaces are easier to read than uncommon typefaces (Tinker 1963).
- Serif typefaces are often considered to be easier to read than sans serif typefaces, except for small letter sizes (Tinker 1963).
- Running text should be in lower case letters. All-capital printing has been shown to markedly reduce the speed of reading (Poulton & Brown 1968; Henny 1981).

Individual characters can be designed in many different ways (Figure 4.3). The differences between many typefaces are subtle. It is not always possible to see the differences without special training. They can be identified by looking for classic traits, such as the shape of specific parts of lower-case letters. A complete assortment of characters of the same style and size is called a *font of type*. However, in

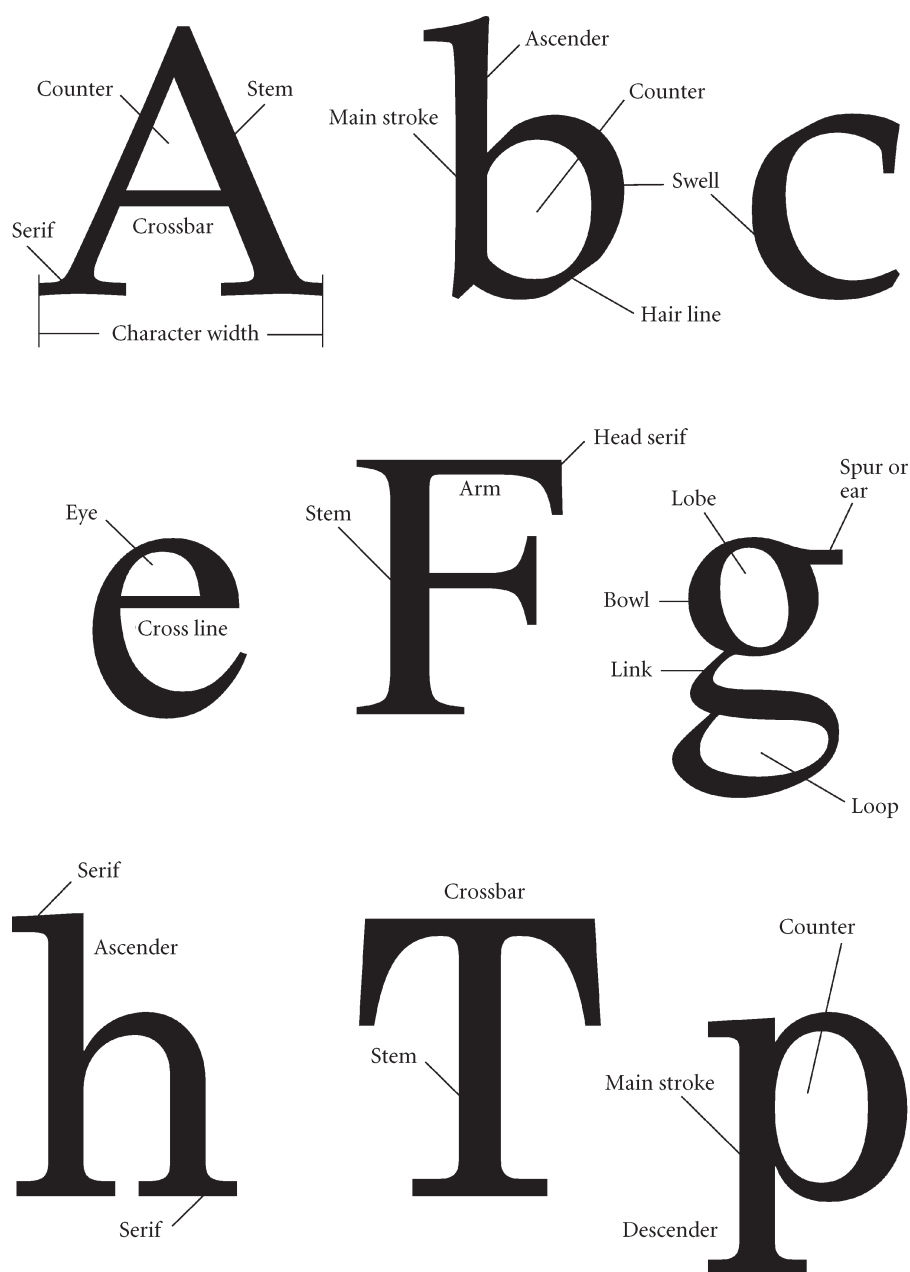


Figure 4.3 Type. The terminology in typography is based on hot metal type composition. Here the letters Abc are set in Palatino, eFg in Times, and hTp in New Century Schoolbook, all in 144 point size.

information

The serifs make it easy to follow a bottom line, a baseline.

information

The upper part of the letters shape the characters and the words.

information

Figure 4.4 Serifs are terminal strokes, normally at the top and bottom of the main strokes of letters in a Roman type style, in this illustration Palatino. Serifs on the characters makes it easier to follow horizontal text lines with the eyes.

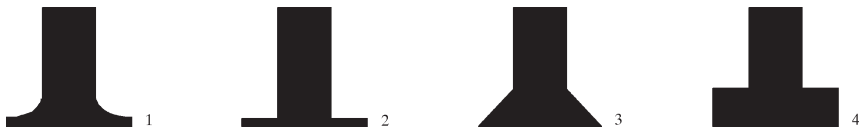


Figure 4.5 Serifs are terminal strokes, normally at the top and bottom of the main strokes of letters in a Roman type style. There are four main types of serifs: (1) bracketed serif, (2) hairline serif, (3) wedge serif, and (4) slab serif.

computer manuals the word *font* is sometimes used to mean typeface, which is confusing.

Many have tried to develop classification schemes of typefaces. Classification systems may be based, e.g., on chronology, on evolution, and on various elements of letter shapes. Most systems are incomplete and more or less confusing. The system that has enjoyed the largest general favour divides typefaces into four main classes: Roman, Sans Serif, Script, and Black letter. Within these classes groups of type designs with important similarities form “type families”.

Roman type style includes most of the typefaces used in modern printing. Roman type has serifs (Figures 4.4 and 4.5). Serifs are the finishing strokes at the ends of the letterforms. Serifs are not just for decoration. They help us distinguish between characters. Serifs also makes it easier to follow horizontal text lines. Thus, serifs increase legibility and aid reading (Tinker 1963). Typefaces are often named after the designers who created them, or after the printers who first used them. Baskerville, Bodoni, Bookman, Caslon, Century, Garamond, Palatino, and Times are all popular Roman typefaces. The French printer Nicolas Jenson worked in

Italy. He perfected the first Roman style type already in 1470. In France Claude Garamond created the Garamond-style about 1540. In England William Caslon designed the Caslon-style in 1734; and John Baskerville created the Baskerville-style about 1757. In Italy Giambattista Bodoni designed a new kind of Roman type style in 1768. For more than 200 hundred years the Bodoni-style has been called *modern* or modern type.

Sans serif type has no serifs on the characters. Avant Garde, Futura, Gill, Helvetica, Optima, Univers, and Venus are examples of popular sans serif type-faces. Sans serif typefaces are often used for captions, for words in figures, and for headings.

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

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

A more modern classification scheme is the serif-evolution system. This system provides eight main classes: Venetian, Old Style (Dutch-English and French), Transitional, Modern, Contemporary (sans serif and square serifs), Black letter, Scripts, and Decorative letters. Most typefaces are *proportionally spaced*. Then different letters are assigned different spacing in accordance with their individual sizes and shapes. However, on most typewriters and some printers the typefaces are *monospaced*. In such typefaces all the letters have the same amount of space



Figure 4.6 Letter space. Proportionally spaced type (top) is usually easier to read than monospaced type (bottom). Note the differences in character space, especially for the letters i and m. The characters are set in 72 point Geneva.

(Figure 4.6). The letter “i” takes the same space as the letter “m”. Proportionally spaced type is usually easier to read than monospaced type.

As mentioned earlier, thousands of fonts are available. In the practical work with *graphic design for information*, we need only a few typefaces in different versions, like Times, Palatino, Bookman, New Century Schoolbook, Helvetica, and Avant Garde for desktop publishing.

Times

abcdefghijklmnopqrstuvwxyzABCDEFGHIJKLMNOPQRSTUVWXYZ ,,:!?"()
/&%+ -=><*1234567890

Infology is the science of verbo-visual presentation and interpretation of information. On the basis of man’s prerequisites, infology encompasses studies of the way a verbo-visual representation should be designed in order to achieve optimum communication between sender and receiver. Infology models contain both theoretical (descriptive) elements and normative (prescriptive) elements.

Palatino

abcdefghijklmnopqrstuvwxyzABCDEFGHIJKLMNOPQRSTUVWXYZ ,,:
!?"()/&%+ -=><*1234567890

Infology is the science of verbo-visual presentation and interpretation of information. On the basis of man’s prerequisites, infology encompasses studies of the way a verbo-visual representation should be designed in order to achieve optimum communication between sender and receiver. Infology models contain both theoretical (descriptive) elements and normative (prescriptive) elements.

Bookman

abcdefghijklmnopqrstuvwxyzABCDEFGHIJKLMNOPQRSTUVWXYZ
,,:!?"0/&%+ -=><*1234567890

Infology is the science of verbo-visual presentation and interpretation of information. On the basis of man’s prerequisites, infology encompasses studies of the way a verbo-visual representation should be designed in order to achieve optimum communication between sender and receiver. Infology models contain both theoretical (descriptive) elements and normative (prescriptive) elements.

New Century Schoolbook

abcdefghijklmnopqrstuvwxyzABCDEFGHIJKLMNOPQRSTUVWXYZ
.,:;!?"()/&%+ -=><*1234567890

Infology is the science of verbo-visual presentation and interpretation of information. On the basis of man’s prerequisites, infology encompasses studies of the way a verbo-visual representation should be designed in order to achieve optimum communication between sender and receiver. Infology models contain both theoretical (descriptive) elements and normative (prescriptive) elements.

Helvetica

abcdefghijklmnopqrstuvwxyzABCDEFGHIJKLMNOPQRSTUVWXYZ ,.:;!?"
()/&%+ -=><*12 34567890

Infology is the science of verbo-visual presentation and interpretation of information. On the basis of man’s prerequisites, infology encompasses studies of the way a verbo-visual representation should be designed in order to achieve optimum communication between sender and receiver. Infology models contain both theoretical (descriptive) elements and normative (prescriptive) elements.

Avant Garde

abcdefghijklmnopqrstuvwxyzABCDEFGHIJKLMNOPQRSTUVWXYZ ,.:!
!?"()/&%+ -=><*1234567890

Infology is the science of verbo-visual presentation and interpretation of information. On the basis of man’s prerequisites, infology encompasses studies of the way a verbo-visual representation should be designed in order to achieve optimum communication between sender and receiver. Infology models contain both theoretical (descriptive) elements and normative (prescriptive) elements.

As we can see from the six examples above, different typefaces have their individual characteristics. Notice how the different typefaces vary in space and in their visual appeal. Some are more legible and some are less legible. In the USA children usually learn to read using textbooks with serif typeface like New Century Schoolbook. In European countries it is not unusual that sans serif typefaces are used in textbooks. Children in China learn to read the complicated Chinese characters. And we can find equally good readers in all these countries. As a matter of fact, the reader should never become too conscious of the typeface.

A “good” typeface might actually be one that is more or less “invisible” to us as readers. We shouldn’t be too concerned with the design of the typeface. The typefaces in common use are all more or less equally legible (Tinker 1963, 1965;

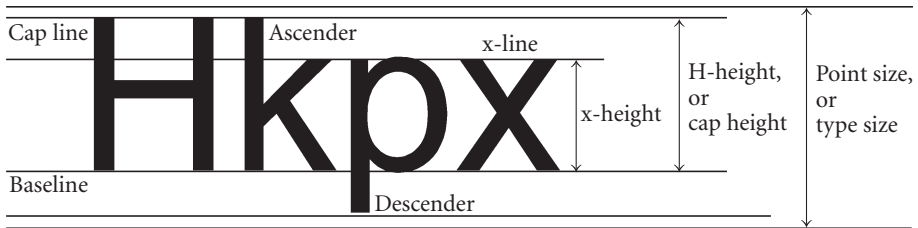


Figure 4.7 Imaginary lines are used in the positioning of letters. The *baseline* is the main point of reference in typography. The *x-height* is the vertical space occupied by lowercase letters (excluding ascenders and descenders). The *H-height* or *cap height* is the height of capital H. The *point size* or *type size* is the vertical space allowed for any character of a typeface. Helvetica 80 points is used in this illustration.



Figure 4.8 The x-heights vary in different typefaces. In this example we can compare Times, Palatino, Bookman, New Century Schoolbook, Helvetica, and Avant Garde, all in 80 points.

Paterson & Tinker 1932). However, readers are likely to have strong preferences about the aesthetics of typefaces. One important aspect of the design of a typeface is the perceived size of the individual characters (Figure 4.7). Some type looks big and some type looks small. This depends on the design of the characters and their *x-height* (Figure 4.8).

A typeface can influence our appraisal of a printed message. Thus, it might be important to make a choice so that typography reinforces the message. The original *Times New Roman* was created in 1932 by the graphic designer Stanley Morrison for the London newspaper *The Times*. The mission was to create a typeface with very good legibility even in small sizes. Several versions of Times have been developed. Typefaces and fonts belonging to “the Times family” are all easy to read. They are compact with strong serifs and are often considered attractive. Times typefaces are used in newspapers and magazines as well as in books. They are probably the most widely used serif typefaces in the world. The typeface Times fills the criteria and requirements for good legibility in print media. However, also other common font families like Baskerville, Berling, Bookman, Garamond, New Century Schoolbook, and Palatino can be used successfully for the body text. Times typefaces are not very easy to read on computer screens.

Illustration – Illustration

Figure 4.9 Similarities. In Helvetica the similarities between capital I and lower case l cause problems in words like “Illustration”, here compared with Palatino.

Palatino was created by Hermann Zapf in 1950. He was inspired by the handwritings in manuscripts from the 14th century. In my view *Palatino* is an interesting typeface. It is easy to read on paper as well as on computer screens. *Palatino* is sometimes considered to be a “formal” typeface. Thus, it is often used in various business proposals and business reports.

Bookman was created by C. H. Griffith in 1936. It is now a classic typeface with open and round letter shapes. *Bookman* is often used in books as well as in printed matter and in many other kinds of graphical media. In the USA Misanchuk (1989) asked learners to compare samples of text made up of all possible combinations of the fonts *Bookman*, *Courier*, *Helvetica*, *New Century Schoolbook*, and *Times*, all in 10-point size. They were asked to make their judgments based on the question, “Which of these two pages of text do you think it would be most easy to read and study from?” The order of preference was *Bookman*, *New Century Schoolbook*, *Courier*, *Helvetica*, and *Times*.

New Century Schoolbook was originally developed by Morris Fuller Benton in 1926 for use in school textbooks. It is a rather wide typeface which is easy to read. *New Century Schoolbook* is often used in textbooks and also in many other books.

Helvetica was created by Max Miedinger in 1957. It is the ultimate design of the Bauhaus–Swiss–International schools. *Helvetica* is designed with simple, striking lines in a compact way. Like *Times*, *Helvetica* has been developed in many typefaces and font versions. *Helvetica* typefaces are very useful for titles, headings, legends, and tables of various kinds but they might be hard to read in running text. The similarities between capital I and lower case l cause problems in words like “Illustration” (Figure 4.9).

Running text in *Helvetica* will need extra space between the lines. *Helvetica* is often used for reader slides, overhead transparencies and in business graphics. According to (Collier & Cotton 1989) *Helvetica* typefaces may be the most widely used sans serif typefaces in the world today. In some books *Helvetica* are used for the headings, for the figure legends and for the labels in the figures.

Avant Garde was created in 1970 by the well known American graphic designer Herb Lubalin. *Avant Garde* has a geometric and symmetrical appearance. It is often used for titles and headings in different kinds of printed matter. *Avant Garde* is also used on signs and in visual communications but it is not good for running text.

4.2.2 Size of type

The legibility of a graphical message is determined by the technical quality of its text and pictures and can be measured somewhat objectively. In fact, the degree of legibility is not at all defined by whether we understand the contents of the message or not. As for the text, we should avoid using unusual typefaces as well as type sizes that are too big or too small. In the first case we cannot read them at all. In the second case we can only have a few words on each line. Too small or too large lettering impairs reading. We read texts as a series of “word pictures”, not letter by letter (Ingvar & Hallberg 1989; Hallberg 1992).

Our perception of size is always relative. According to White (1987), some 10-point type looks gigantic and some minuscule. It all depends on the design of the face and its x-height. Letters can be varied in size and even by type to differentiate different types of data (Hartley 1987). To achieve optimum legibility it is known that letter size must be adjusted to the visual format and the reading distance. According to Tinker (1963) text smaller than nine points is too small to be considered legible. Text which should be read in a continuous manner should be set between nine and twelve points (Tinker 1963; Haber & Haber 1981; Benson 1985; Braden 1983, 1985). A 12 point normal type is often suitable for a “normal” page size like A4 or letter. In its *Publication Manual* the American Psychological Association (1996: 151) recommends a minimum type size of 8 point in figures. The maximum size is 14 point. According to Lenze (1991) font size above twelve points slows the reading process because the reader must examine each letter individually to recognize it.

Thus, we can conclude that type should be “large enough”. A larger type size in a single column is preferable to a smaller type size in a double column layout. But the text on a display poster should be at least three to five times as large. The text on a poster that is meant to be read from a distance might require text that is at least ten times as large.

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

- The *Pica system* is used in USA and in Great Britain. Here 1 pica = 12 points = 12 pts = 1/6 inch = .1667 inch = 4.2333 mm. 1 pt = .3528 mm
- The *Didot system* is used in most parts of Europe (except Great Britain and France). Here 1 cicero = 12 points = 12 p = .1780 inch = 4.511 mm. 1 pt = .3759 mm
- The *Mediaan system* is used in France. Here 12 points = .1649 inch = 4.205 mm. 1 pt = .3504 mm

The differences may be significant in many situations. The most common programs for desktop publishing use the Pica system, giving points as “pts”. Here are some examples of a text in different size versions:

Palatino 7. Infology is the science of verbo-visual presentation and interpretation of information. On the basis of man’s prerequisites, infology encompasses studies of the way a verbo-visual representation should be designed in order to achieve optimum communication between sender and receiver. Infology models contain both theoretical (descriptive) elements and normative (prescriptive) elements.

Palatino 8. Infology is the science of verbo-visual presentation and interpretation of information. On the basis of man’s prerequisites, infology encompasses studies of the way a verbo-visual representation should be designed in order to achieve optimum communication between sender and receiver. Infology models contain both theoretical (descriptive) elements and normative (prescriptive) elements.

Palatino 9. Infology is the science of verbo-visual presentation and interpretation of information. On the basis of man’s prerequisites, infology encompasses studies of the way a verbo-visual representation should be designed in order to achieve optimum communication between sender and receiver. Infology models contain both theoretical (descriptive) elements and normative (prescriptive) elements.

Palatino 10. Infology is the science of verbo-visual presentation and interpretation of information. On the basis of man’s prerequisites, infology encompasses studies of the way a verbo-visual representation should be designed in order to achieve optimum communication between sender and receiver. Infology models contain both theoretical (descriptive) elements and normative (prescriptive) elements.

Palatino 11. Infology is the science of verbo-visual presentation and interpretation of information. On the basis of man’s prerequisites, infology encompasses studies of the way a verbo-visual representation should be designed in order to achieve optimum communication between sender and receiver. Infology models contain both theoretical (descriptive) elements and normative (prescriptive) elements.

Palatino 12. Infology is the science of verbo-visual presentation and interpretation of information. On the basis of man’s prerequisites, infology encompasses studies of the way a verbo-visual representation should be designed in order to achieve optimum communication between sender and receiver. Infology models contain both theoretical (descriptive) elements and normative (prescriptive) elements.

Palatino 13. Infology is the science of verbo-visual presentation and interpretation of information. On the basis of man’s

prerequisites, infology encompasses studies of the way a verbo-visual representation should be designed in order to achieve optimum communication between sender and receiver. Infology models contain both theoretical (descriptive) elements and normative (prescriptive) elements.

Palatino 14. Infology is the science of verbo-visual presentation and interpretation of information. On the basis of man's prerequisites, infology encompasses studies of the way a verbo-visual representation should be designed in order to achieve optimum communication between sender and receiver. Infology models contain both theoretical (descriptive) elements and normative (prescriptive) elements.

Different size versions provide different impressions (Figure 4.10). In information design it is important to find a good balance between our need for a general overview and good legibility of individual words. In books, magazines, and newspapers larger type are usually used for headings.

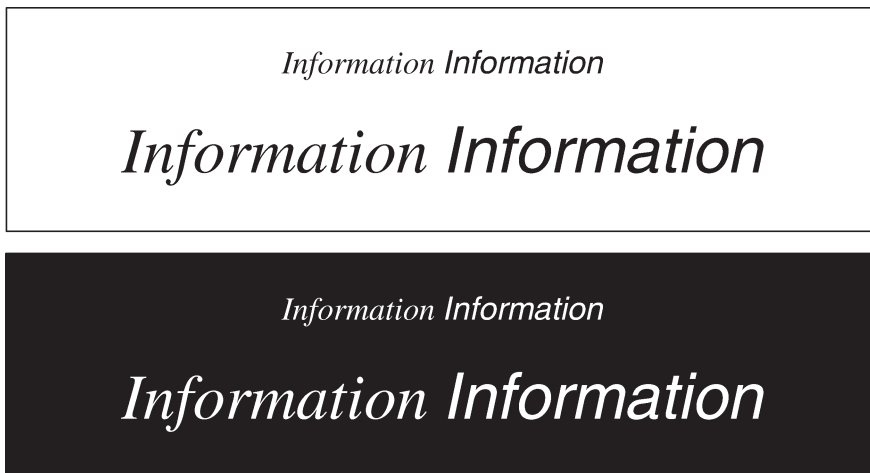


Figure 4.10 White text on a black background should usually be larger than traditional black text on a white background. These examples are set in italics, 12 and 24 points respectively. Fine lines in a Roman type style (Times) may sometimes almost “disappear” (lower left). It is better to use a sans serif type (Helvetica) when the text is white on a black background (bottom right).

4.2.3 Stylistic variation of type

With respect to width and line thickness a character can be designed in different versions. A typeface may be available as light condensed, light, light expanded, bold condensed, bold, bold expanded, regular condensed, regular, regular expanded, extra bold condensed, extra bold, and extra bold expanded. With respect to inclination a typeface may be designed in italic letter style versions. A typeface may also be available as outlined, inlined, and shadowed. The visual weight, or visual impression vary. It may be compared with physical weight. A small and extra bold and expanded character may be seen as heavier than a large, light and condensed character.

To achieve optimum legibility it is known that regular type is easier to read than uncommon type. Boldface or italics should normally not be used for continuous text. Italic print is read more slowly than regular type and is also disliked by many readers (Tinker 1965). However, boldface and italics may be used for *emphasis*. Italics may be used for small parts in a running text, for headings, and for legends. Bold type may be used for headings. Different style manuals have different recommendations for when italic and bold type versions should and shouldn't be used. The use of underlining and all capital letters should be restricted to headings and titles, if they are used at all. Usually bold and italics are quite sufficient. Underlining in the middle of a sentence makes the lower line more difficult to read (Isaacs 1987). Shadow, outline letters, and reverse type like white type on black background should be avoided because they are hard to read.

Palatino 12 p regular

Infology is the science of verbo-visual presentation and interpretation of information. On the basis of man's prerequisites, infology encompasses studies of the way a verbo-visual representation should be designed in order to achieve optimum communication between sender and receiver. Infology models contain both theoretical (descriptive) elements and normative (prescriptive) elements.

Palatino 12 p italic

Infology is the science of verbo-visual presentation and interpretation of information. On the basis of man's prerequisites, infology encompasses studies of the way a verbo-visual representation should be designed in order to achieve optimum communication between sender and receiver. Infology models contain both theoretical (descriptive) elements and normative (prescriptive) elements.

Palatino 12 p bold

Infology is the science of verbo-visual presentation and interpretation of information. On the basis of man's prerequisites, infology encompasses studies of the way a verbo-visual representation should be designed in order to achieve optimum communication between sender and receiver. Infology models contain both theoretical (descriptive) elements and normative (prescriptive) elements.

Palatino 12 p bold italic

Infology is the science of verbo-visual presentation and interpretation of information. On the basis of man's prerequisites, infology encompasses studies of the way a verbo-visual representation should be designed in order to achieve optimum communication between sender and receiver. Infology models contain both theoretical (descriptive) elements and normative (prescriptive) elements.

As we can see from these examples, different type versions have their individual characteristics. The most common type versions are easier to read than uncommon type versions. Typography can be used to modulate a message. A text will retain its content even when type design is changed. However, our perception of the content will change. Graphic design can be and should be used to build consistency and aid communication. Glynn, Britton, and Tillman (1985) reviewed studies on the effect of "typographic cuing" on learning. Typographic cuing generally refers to the use of bold or italic type or underlining to signal the important ideas in a text. There was little doubt that cuing does work in drawing attention to the cued material. The consensus was that readers are more likely to remember cued ideas than uncued ideas (Hartley 1987).

4.2.4 Justified or unjustified text?

The text can be justified or unjustified. An unjustified text can be flushed left, centre justified, or flushed right. Below are four examples of the same text in different versions; justified, centre justified, flushed left, and flushed right:

Justified text: Infology is the science of verbo-visual presentation and interpretation of information. On the basis of man's prerequisites, infology encompasses studies of the way a verbo-visual representation should be designed in order to achieve optimum communication between sender and receiver. Infol-

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

Centre justified text: Infology is the science of verbo-visual presentation and interpretation of information. On the basis of man's prerequisites, infology encompasses studies of the way a verbo-visual representation should be designed in order to achieve optimum communication between sender and receiver. Infology models contain both theoretical (descriptive) elements and normative (prescriptive) elements.

Flushed left text: Infology is the science of verbo-visual presentation and interpretation of information. On the basis of man's prerequisites, infology encompasses studies of the way a verbo-visual representation should be designed in order to achieve optimum communication between sender and receiver. Infology models contain both theoretical (descriptive) elements and normative (prescriptive) elements.

Flushed right text: Infology is the science of verbo-visual presentation and interpretation of information. On the basis of man's prerequisites, infology encompasses studies of the way a verbo-visual representation should be designed in order to achieve optimum communication between sender and receiver. Infology models contain both theoretical (descriptive) elements and normative (prescriptive) elements.

Justified text (sometimes called right-justified text or full text) is commonly used for running text in books, magazines, and newspapers. To achieve a justified text the technical system inserts extra space between words and between characters. According to Kleper (1987), the practice of having text justified is a tradition in the publishing industry which originated with the scribes who copied text by hand before the invention of movable type. At that time paper was expensive and the scribes attempted to put as much text as possible onto every page, filling each line completely. Burns, Venit, and Hansen (1988) pointed out that the use of metal type required that the right edges of type align in the page form so that the type could be locked into place. Until recently anything other than justified text had been regarded as unprofessional by most publishers. Lang (1987) argued that justified text is aesthetic, it serves to define the right margin, and it is familiar to the readers. Like Lang, Lichty (1989) also argued that it is easier to read lines of the same length than lines with markedly varying righthand ends.

Today flushed left text with a "ragged-right-hand" edge is commonly used for running text in books, magazines, and some newspapers. A century ago flushed left text was restricted to poetry. At that time it was considered very odd and pe-

cular. Hartley (1985) and Hartley and Burnhill (1977) argued that justified text is not a good idea for instructional materials. The variable spacing between words as well as the use of hyphenation makes reading less smooth and more difficult. Trollip and Sales (1986) experimented with justified and flushed left text. Results indicated significant increase in reading time for groups reading justified text. No differences in comprehension were detected. The advantage with flushed left and ragged right text is that it retains the optimal spacing between letters and between words and so keeps the visual rhythm constant. This aids reading, especially for young and inexperienced readers. Poor readers have difficulty reading justified text (Zachrisson 1965; Gregory & Poulton 1970). However, whether the text is justified or unjustified causes no significant difference in search time and comprehension of the information for advanced readers (Hartley 1987). Justification should especially be avoided with narrow columns in multi-columnar layouts (Davies, Barry, & Wiesenbergs 1986). Misanchuk (1992) claims that there are no good arguments at all for using justified text. However, many readers find justified text much more aesthetically pleasing than flushed left text. They may even feel that the ragged right is ugly and repulsive. Centre justified texts are often used for menus and sometimes for poetry and also for tables of contents. Flushed right texts can be used for legends positioned to the left of pictures or for tables of contents. This is only possible when the line length is short.

4.3 Reading print media

The readers should be able to focus their interest on the actual contents of the message. We need to use typefaces and type sizes with good legibility. Some of the better-known examples among the Roman font families are Baskerville, Berling, Garamond, New Century Schoolbook, Palatino, and Times, and among the “linear” font families: Futura, Gill, Helvetica, and Univers. There are always several variants among the better-known typefaces, and they may differ a great deal.

According to the criteria of good legibility, easy availability and good economy, the choice often falls on Times and Helvetica. As previously noted these two may be the world’s most frequently used typefaces. The graphical form should help the reader to benefit from the contents of a document. We can easily clarify the structure of a document with a distinct table of contents and explicit headings, shown in differentiated, consistent, and well-thought-out typography. The graphical form should be *consistent*. Headings, introductions, the main body of the text, and picture captions should be presented in a consistent way throughout the entire document. The same applies to series of related documents. On the other hand, different types of documents can be rendered in different graphical forms. It is an

advantage to the reader to be able to recognize different kinds of documents on sight, for example, a factual study book, a year-book, a glossary, an encyclopedia, or an instructor's guide, on the basis of the different graphical forms. Graphical form must be adapted to the various needs and special requirements of each type of document and each page size.

Good legibility is always economically advantageous, whereas poor legibility is a costly business. Good models make the production of documents simple and inexpensive. It is not economical to cram too much information on every page. It is better to edit the text and reduce its bulk, and thereby increase its legibility. If a document is to have many readers who will try to read and understand it during working hours, the cost of reading the document will be the greatest expense it incurs. Even though it may be expensive to produce information, it usually costs even more to store, access, and use it. Therefore, the more people who will partake of certain information, the greater the total cost will be. Because the cost of reading is closely linked to the type of material in the document and to the various groups of readers it targets, there will be great opportunities to reduce the total costs and save money by presenting the information in a suitable fashion.

4.3.1 Line length

According to Tinker (1963), readers tend to dislike both very short and very long line lengths. West (1987) suggested that the line length should be 35–40 characters. Quite often the optimum line length seems to be about 1 1/2 alphabets – 42 characters (Pettersson 1989; Walker 1990). This is nine to eleven centimetres with optimum character size, ten to twelve point, at a normal reading distance. Parker (1988) suggested 50 characters. Burns, Venit, and Hansen (1988) suggested up to 60 characters. Miles (1987) suggested 60–65 characters. It is quite clear that too wide lines impair reading. In my opinion the maximum line length should not be much more than 60–70 characters, except for books intended for highly skilled readers. Costs often force people to use more characters on each line, so that the total number of pages can be reduced. However, the longer the lines the wider the vertical space between them needs to be (Waller 1987).

The length of a line will affect reading speed (Duchnick & Kolers 1983). Different kinds of publications should use different line lengths. The optimum line length should be found for each individual purpose and audience. As previously noted the width of a line of type is traditionally measured in picas or cicero. A pica, as well as a cicero, equals 12 points. As systems for desktop publishing become more common, line lengths will be measured in inches or centimetres instead of picas or ciceros. The line length may vary considerably. The longer the

line is, the larger the type size should be. The shorter the line is, the smaller the type size may be.

Too short lines 1

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

Too short lines 2

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

Short lines 1

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

Short lines 2

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

Optimum line length 1

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

Optimum line length 2

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

Long lines 1

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

Long lines 2

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

If justified text is set in lines too short, you get rivers of space between words, or characters spaced out to fill. A line of 40 to 50 characters or "strokes" results in a line length of 75 to 90 millimetre in a book or a paper. A text column may be widened up to 120 millimetre to accommodate more text, and still be easy to read for an experienced reader. However, Zwaga, Boersma and Hoonhout (1999:xxii) argued that there is no such thing as the "best" column width or line length. The typographic features of printed matter should be chosen in relation to the requirements of the material to be printed. Line length can be relevant in the context of material consisting of sentences grouped in paragraphs, but as less important when there are also components such as tables, lists, diagrams and mathematical formulae. In these cases the constraints of a narrow column might be a disadvantage.

4.3.2 Interline distance

The "interline distance", "interline spacing", "line space", or "vertical spacing" is the vertical distance between the baselines in a text. An 11-point text may be set on a 13-point line. This is written as 11/13, and read as "eleven on thirteen". The term "leading" may refer to the extra space between lines. In this case the interline distance is 13 points, and thus the leading is two points. The leading may vary considerably between different kinds of texts. Here are some examples.

Palatino 12/10

Infology is the science of verbo-visual presentation and interpretation of information. On the basis of man's prerequisites, infology encompasses studies of the way a verbo-visual representation should be designed in order to achieve optimum communication between sender and receiver. Infology models contain both theoretical (descriptive) elements and normative (prescriptive) elements. Producers of information and learning materials can facilitate communication, and the learning processes of the readers. Complicated language, in both texts and pictures, will impair the understanding of the message. Active voice, clarity, comprehensibility, consistency, legibility, precision, readability, reading value, simplicity, and structure are the key concepts in information design.

Palatino 12/11

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Palatino 12/12

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Palatino 12/13

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Palatino 12/14

Infology is the science of verbo-visual presentation and interpretation of information. On the basis of man's prerequisites, infology encompasses studies of the way a verbo-visual representation should be designed in order to achieve optimum communication between sender and receiver. Infology models contain both theoretical (descriptive) elements and normative (prescriptive) elements. Producers of information and learning materials can facilitate communication, and the learning processes of the readers. Complicated language, in both texts and pictures, will impair the understanding of the message. Active voice, clarity, comprehensibility, consistency, legibility, precision, readability, reading value, simplicity, and structure are the key concepts in information design.

Palatino 12/15

Infology is the science of verbo-visual presentation and interpretation of information. On the basis of man's prerequisites, infology encompasses studies of the way a verbo-visual representation should be designed in order to achieve optimum communication between sender and receiver. Infology models contain both theoretical (descriptive) elements and normative (prescriptive) elements. Producers of information and learning materials can facilitate communication, and the learning processes of the

readers. Complicated language, in both texts and pictures, will impair the understanding of the message. Active voice, clarity, comprehensibility, consistency, legibility, precision, readability, reading value, simplicity, and structure are the key concepts in information design.

Palatino 12/16

Infology is the science of verbo-visual presentation and interpretation of information. On the basis of man's prerequisites, infology encompasses studies of the way a verbo-visual representation should be designed in order to achieve optimum communication between sender and receiver. Infology models contain both theoretical (descriptive) elements and normative (prescriptive) elements. Producers of information and learning materials can facilitate communication, and the learning processes of the readers. Complicated language, in both texts and pictures, will impair the understanding of the message. Active voice, clarity, comprehensibility, consistency, legibility, precision, readability, reading value, simplicity, and structure are the key concepts in information design.

Palatino 12/17

Infology is the science of verbo-visual presentation and interpretation of information. On the basis of man's prerequisites, infology encompasses studies of the way a verbo-visual representation should be designed in order to achieve optimum communication between sender and receiver. Infology models contain both theoretical (descriptive) elements and normative (prescriptive) elements. Producers of information and learning materials can facilitate communication, and the learning processes of the readers. Complicated language, in both texts and pictures, will impair the understanding of the message. Active voice, clarity, comprehensibility, consistency, legibility, precision, readability,

reading value, simplicity, and structure are the key concepts in information design.

Palatino 12/18

Infology is the science of verbo-visual presentation and interpretation of information. On the basis of man's prerequisites, infology encompasses studies of the way a verbo-visual representation should be designed in order to achieve optimum communication between sender and receiver. Infology models contain both theoretical (descriptive) elements and normative (prescriptive) elements. Producers of information and learning materials can facilitate communication, and the learning processes of the readers. Complicated language, in both texts and pictures, will impair the understanding of the message. Active voice, clarity, comprehensibility, consistency, legibility, precision, readability, reading value, simplicity, and structure are the key concepts in information design.

Palatino 12/19

Infology is the science of verbo-visual presentation and interpretation of information. On the basis of man's prerequisites, infology encompasses studies of the way a verbo-visual representation should be designed in order to achieve optimum communication between sender and receiver. Infology models contain both theoretical (descriptive) elements and normative (prescriptive) elements. Producers of information and learning materials can facilitate communication, and the learning processes of the readers. Complicated language, in both texts and pictures, will impair the understanding of the message. Active voice, clarity, comprehensibility, consistency, legibility, precision, readability,

reading value, simplicity, and structure are the key concepts in information design.

As previously noted the longer the lines, the larger the vertical distance should be. The reader needs to be able to find the next line without any trouble. In general, the opinion is that as the line length is increased, the need for more leading and larger type increases (Misanchuk 1992). For maximum legibility of print on paper Tinker (1963) and Pettersson (1989) recommended a leading of one to two points in a continuous text when text size is optimal. Hartley (1987) recommended 1.5 points, and Benson (1985) recommended two points. Kleper (1987) recommended a leading of about 20% and Lichty (1989) recommended 25%. Children and inexperienced readers need more leading than experienced readers. Text on posters and overheads need more space than text on paper.

4.3.3 Spacing

Graphic design should be based on perceptual, rather than on physical phenomena. Compensation for shortcomings of our human vision is often required. Visual alignment depends on careful optical adjustment to compensate for differences in shape of the element being aligned (Figure 4.11). Wendt (1979) inserted additional space between the constituents of the sentences to better convey the phrase structure of the text but found no difference in learning efficiency when compared with traditional text in one or in two columns.

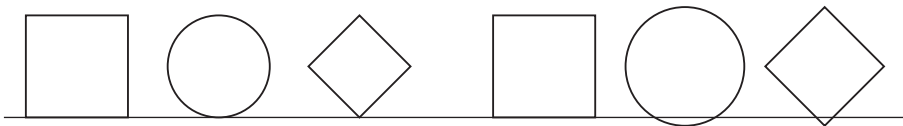


Figure 4.11 Scaling. With physically equivalent scaling (left group), rounded and acute shapes appear too low relative to a rectangular or square element resting on a baseline. With optical equivalent scaling (right group), rounded and acute shapes are extended in order to appear to be of equal height relative to a rectangular element. We have to fool the eye.

Text with a generous amount of space within it is rated as “easier” and “more interesting” than text which has a more solid appearance. For comfortable reading it must be easy to distinguish between words. The distance between words should be relatively small. When the text has optimal spacing we can keep the reading rhythm constant. The distance between characters is sometimes too long. This is especially true for headlines in capitals. In hand typesetting spacing of type is done by using thin strips of metal from 0.5 point upwards. In electronic systems “empty

space” is added automatically between the words and between letters when the text is set in justified lines.

The amount of space between words and between letters varies in each line depending on the actual words and the actual line length. First the computer system adds word-spacing and then, if the space between words becomes too excessive, the system will add letter-spacing. Below are four examples of the same text (Palatino 18/22) with different spacings between the words: (1) condensed, (2) normal, (3) expanded with one space, and (4) expanded with two spaces:

1 Visual information
2 Visual information
3 Visual information
4 Visual information

In photo-typesetting *Kerning* is used to individually correct the distance between characters to achieve a better type (Figure 4.12). For example, when a capital A and a capital T, V, or Y are set without kerning, there is too much space between the letters. The A, V, and Y have slanted shapes, and the T has empty space at the bottom. Thus, the spaces between these letters are exaggerated.

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

Hewson (1988) noted that it isn’t worthwhile kerning any type under 18 points. It is worthwhile to use kerning for headings and also for texts on OH trans-



Figure 4.12 Kerning. In large fonts (here Palatino 48 points) it is necessary to apply kerning (lower example) and correct the distance between characters to achieve better legibility.

parencies. In photo-typesetting it is also possible to automatically and systematically reduce the distance between characters, or to condense the text. It is also possible to automatically and systematically increase the distance between characters, or to expand the text. This is also possible in some systems for desktop publishing. Here are four examples of the same text (Palatino 18/22) in different spacing versions: (1) condensed with one point, (2) normal spacing, (3) expanded with one point, and (4) expanded with two points.

1 Visual information

2 Visual information

3 Visual information

4 Visual information

Vertical and horizontal markings can be used to mark new paragraphs clearly. Often a thin “white line” of two to seven points extra space may be used to separate the paragraphs in the text. Every paragraph, except for those that come directly after a heading, has an indent of five to nine millimetre, that is, the first line of a paragraph begins slightly to the right of the left margin (see this and other paragraphs). However, an indent on the first line directly after a heading gives an unbalanced, restless impression.

4.3.4 Headings

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 structure is built into the text itself. External textual structure relates to the embedded strategies which focus a reader’s attention on particular parts of the text (Jonassen & Kirschener 1982). Headings, or headlines, 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. To avoid too large masses of text, it is a good idea to divide the text into sections and subsections. Headings on different hierarchic levels will provide the readers with reference points and help them organize information cognitively for better retention and recall. Headings set in different type versions aid comprehension of the text content (Jonassen 1982).

To achieve a clear structure we can use a combined numbering and lettering system (Jonassen 1982). Main points in a text are traditionally labelled with

Roman numerals (I, II, III, etc.). Subpoints of the first degree are traditionally labelled with capital letters (A, B, C, etc.). Second degree subpoints are traditionally labelled with Arabic numerals (1, 2, 3, etc.). The labelling hierarchy is I, A., 1., a., (1), (a). In Europe it is common to use a numbering system only (e.g., 1, 1.1, 1.2, 1.3; 2, 2.1, 2.2, 2.3; 3, 3.1, 3.2, 3.3, etc.). This system is used in this book. Numbering and lettering systems can be combined with typographic cuing of headings. Headings set in different type versions aid comprehension of the material. We can use a special typeface for headings, for example a sans serif typeface like Avant Garde, Futura, Gill, or Helvetica. We can vary the type size and/or use different type versions. According to a rule of thumb called the “Rule of X’s”, the height of the upper-case X of a smaller typeface should be the same as the height of the lower-case x of a larger typeface in a hierarchy. Also, the use of space and the actual placement of a heading can be used to enhance the hierarchic structure.

Although we usually do not place periods after headings, exclamation point and question marks are used when applicable. Each chapter may begin on a right-hand page and contain the number of the chapter and the chapter’s heading.

4.3.5 Paragraphs

Readers prefer small text paragraphs to big ones. Often it is quite easy to divide the text in hierarchic and natural parts, portions, or sections. Natural breaks emphasized by typography are helpful. Providing “white space” between portions of the text provides cues to the learners that a new section or a new type of activity follows. The end of a sentence should be determined by syntax rather than by a set width of a line (Hartley 1980; Bork 1982). Paragraph indents or spaces between paragraphs can be used for emphasis.

Paragraph indents or spaces between paragraphs can be used for emphasis. There are a few possibilities to emphasize paragraphs. Paragraphs may be indented and/or separated with extra space. According to Tinker (1963) indenting of the first sentence of each paragraph improves legibility by 7% for both single and double line spacing. Indenting of every sentence will however slow down reading speed. According to Frase and Schwartz (1970) indenting the first sentence of each paragraph improves comprehension of printed materials. An indent is the distance between the beginning of a line and the left margin. *First line indents* are used for the running text in this book. *Hanging indents* are used in numbered paragraphs (with or without numbers) and in different “tables”. *Nested indents* may be used to graphically show the relationship between sections, sub-sections and paragraphs within a text. When a paragraph extends into the left or right margin this is called negative indents. In this book *negative indents* are used in the reference list. The

width of an em dash is commonly used for paragraph indentation. This width is equal to the height of the type. So in 12 point type an em dash is 12 points wide.

There are usually no problems with continuation of text in books. The text fills up page after page. However, in magazines and other periodical publications, it is sometimes necessary to use continuation marks like arrows or triangles and references to page numbers. In these situations it might also be a good idea to use “terminal-marks” after the last paragraph in the article. Such a mark is often a circle or a square, filled or unfilled. Sometimes the terminal mark is the initials or the signature of the writer. It is considered to be bad typography to allow an indent on the bottom line of a page. It is also considered bad to end a paragraph on the first line of a page. To avoid this it might be possible to edit the text until it fits. The extra space between paragraphs may vary, depending on the material.

4.3.6 Pictures and charts

Pictures are frequent in many kinds of information materials. Often, pictures are placed in a column of text, and are centred. As a rule, pictures should be placed where they best serve the presentation. Sometimes small pictures can be placed in the margin, and wide pictures may cover the entire text area of the page. Sometimes visuals benefit from being presented in a group. This may be the case for a photograph and an explanatory drawing, or several photographs or drawings forming a mini-series or a related picture sequence telling a specific story.

A picture without a caption or legend has limited informational value. A picture is usually too ambiguous on its own. A picture legend must describe the picture and guide the reader to the interpretation that the information designer wanted to convey to the reader. Legends are usually placed directly below the picture they describe. There should never be any doubt about which picture a legend belongs to. We may avoid using outsize pictures that will “bleed” over into the margins, and we must be careful to leave a distinct space between pictures and the running text. Above the picture, there should be at least one blank line, if, of course, the picture is not uppermost on the page, in which case the upper margin will provide sufficient empty space. Ideally pictures should be placed between two complete paragraphs and not forced into a paragraph.

Usually we should avoid to have too much text within the actual pictures. The text that is absolutely necessary (that is, key words and labels) may be set in nine point Helvetica with ten point line spacing. Single words that are especially important or have a comprehensive function may be shown in bold face. In English texts, key words and labels usually begin with capital letters. McDougall (1990: ix) concluded that photographs nearly always need a partnership with words that will confirm, clarify and reinforce their messages. Winn (1993) noted that students of-

ten need specific instructions regarding how to look at and interpret a picture. Legends can effectively direct attention where the designer wishes it to be directed within the picture. In information design the main function of legends is to help the reader select the intended content in the picture. We need to tell the reader or viewer what we want her or him to see and learn from the illustration. We need to explain the pictures. However, we may also find legends with several apparently different functions. Sometimes legends are used just as labels. They may convey factual content, or information about events. The legends may function as “bridges” between the main text and the various illustrations. Legends may also evoke emotions in the viewer.

4.3.6.1 *Content of legend*

The legend and the visual should interact as parts of a whole and integrated message. A legend should describe image contents and govern the way a picture is read: a picture producer’s intentions about what the reader is supposed to see and learn from each illustration should be as clear as possible. Legends can tell the reader what pictures can’t. They can convey non-visual senses more effectively than photos. They can tell time, temperature and size. Legends can explain the causes of what a photo shows. They can also explain the consequences that may follow. legends can call attention to what readers may overlook in a picture. Legends should be redundant or relevant to the picture. Then the reader will be able to process the information effectively and create necessary mental representations and reach an understanding of the intended content. We should use legends also in order to explain any techniques that may have been used to create special effects in pictures. A photographer may use filters, special lenses, double exposure and special processing in order to achieve unusual effects. In a similar way a fine artist may use a variety of special drawing techniques.

4.3.6.2 *Form of legend*

A legend should be edited to fit different reader categories, such as general readers (children, teenagers, adults...), technical readers, and specialist readers. McDougall (1990: 134) remarked that a printed photo is, in fact, past tense. However, legends are usually written in present tense to imply immediacy. When an activity must be explained, present tense and active verbs are appropriate. The legend should be brief and easy to understand.

A general reader knows little, if anything, about the subject matter. The legends and the pictures are kept simple, attractive, and informative. They should not be too complicated and, thus, distracting to the reader. A technical reader will understand technical concepts but may not be familiar with special terminology. A specialist reader has a good understanding of the subject matter. Both the text

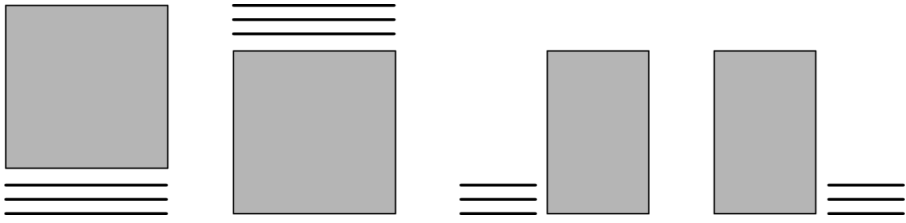


Figure 4.13 Legends. Different ways to place legends. Readers usually expect, though, to find legends beneath the picture as in the first example to the left.

and illustrations, which may consist of detailed drawings, graphs, technical photographs, ultra-sonograms, or other realistic pictures or symbols, may be detailed. An excessively long legend diverts the reader's attention from the main thread in the overall text. Just as it is natural for the main text to refer to the legend, it is equally important for the reader to be able to make her/his way with ease from the legend to the main text – not merely the readers who shift back and forth between the main text and the legend! This also applies to an equal degree to the many readers who begin with the pictures and legends without any intention of reading the entire main text and who are only interested in obtaining detailed information on a particular illustrated section.

4.3.6.3 *Placement of legend*

A legend may be placed in many ways. The legend should always be located close to the picture (Figure 4.13). Readers usually expect to find the legends beneath the pictures. However, legends can also be placed above, to the left, or to the right, of the picture, but never inside the picture frame. Use flushed right text if you want to put the legend to the left of the picture. Use flushed left text if you want to put the legend to the right of the picture. When the legend is put above or beneath the picture, we can use justified text or flushed left text and sometimes even entered text. Sometimes triangles or arrows pointing from the legend towards the picture are used, especially when pictures are gathered together many on a page, e.g., in a magazine. Placing the legend inside the picture makes it harder for people to read the picture as well as the text. Nor should the legend be located on some other page, as happens far too often in reference books and text books used in schools.

4.3.6.4 *Title of legend*

The legend and the visual should interact as parts of a whole. A legend can have a heading as an additional link between the picture and the legend. A good *legend title* provides a short summary of the combined information. The title of a legend

should be short and distinct. Quite often one word is enough. It could give answers to questions like these: Who? What? When? Where? Why? and How?

4.3.6.5 *Typography of legend*

The legend should have a different typographic size or even a different typeface so it can be easily distinguished from the main text. The legends should not be in negative form in a colour picture since the slightest misalignment in printing makes the legends extremely difficult to read. Never make the legend type larger than the main text. The title of the legend may be printed in boldface.

4.3.7 Quotations

Sometimes quotations are included in a text. Short quotations can be integrated into the body text, but long quotations should be distinctly separated from the rest of the text. Any quotation that is used must have the source of reference cited, in keeping with common rules of writing. Here is an example of a short text with an embedded quotation.

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

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

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

In this example, the body text is set with 10.5 point Minion, and the quotation is set in 9.5 point Minion with 13.5 point line spacing. Between the text and the quotation, there are spaces that each corresponds to half a line, that is, 6.75 points in this case. Blank lines like these can be used in various contexts to provide space above and below, for example, pictures, tables, and lists. In fact, we may use “empty lines” or “white spaces” for vertical separation of text elements rather than printed lines of any kind. In this book quotations are normally set in 9.5 point Minion.

4.3.8 Lists and tables

There are several types of lists used in technical documentation and information materials. A book, for example, usually contains a table of contents, a subject index, and a bibliography. It may even contain lists of pictures and tables, or of authors or other persons. The text in the book may have various lists of characteristics, criteria, requirements, or prospects.

4.3.8.1 *The table of contents*

The table of contents immediately follows heading level one, (“Contents”) and may be set in 12 point normal type with 14 point line spacing, left-aligned, and without any extra space before each entry. Page-numbers follow each text on the same line. They may also be flushed right. Chapter designations may be set in bold face, while section designations usually are set in normal typeface. If a table of contents is extensive, it may be rendered in two columns. References to page numbers are often shown for heading levels one to two, or one to three, with indents for each successive level. Heading levels four and five are usually not shown in a table of contents. This would impair the possibility to get an overview and understanding of the overall structure.

4.3.8.2 *Bibliographies*

When each chapter has its own bibliography, the heading “Bibliography” or “References” may be set as a heading 2 in the document. Bibliographies are often voluminous and may take up a great deal of space. Since the reader will usually peruse such a list to find only certain entries, they should be made easy to find. Therefore, the text should be distinct even though it is relatively compact. When there is only one bibliography for a text book, heading level 1 is used. One common bibliography may be a good idea when several references are the same in more than one chapter. Bibliographies may be set in ten point type with 11 point line spacing, with 12 point negative indents. Above them, there may be 2 or 3 points of space, but no extra space is needed below. Indents make it easy to find single references. A bibliography may be laid out to cover the full width of the column. If the bibliography is very extensive we may divide it into two columns that are equal in size, even if the body of the text in the document is arranged in one wide column.

4.3.8.3 *The subject index*

A well-constructed subject index, “Index”, is often an indispensable tool for quickly finding information in books. As is the case with bibliographies, the readers are usually looking only for certain information when they refer to a list of this kind. A subject index may be set in three 50-millimetre-wide columns, in ten point type on 11 point lines, with 12 point indents. It is not necessary to have extra space

between the lines. However, there may be a half a line of space between groups of words that begin with successive letters of the alphabet. The title of the subject index may be set as a header 1.

4.3.8.4 *Lists of items*

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

4.3.8.5 *Notes*

Notes tend to fray the reading fabric. If notes are required, they may be collected in a numbered list at the end of each chapter immediately before the bibliography, and arranged like a list of items with numbers instead of characters to mark them. Occasional notes and brief references may be placed as footnotes at the bottom of the page, or sometimes in the left or right margin. Any notes shown may be set in ten point type with 12 point line spacing, with two point of extra space between each note.

4.3.8.6 *Tables*

Numeric data can be used to illustrate several different situations, such as chronological changes in single quantities or sets of quantities, parts of a whole, and relationships between two or more variables. There are different ways to present numeric data. In print media numeric data can be presented in text, as figures and digits, in tables, or in various graphical formats. No more than one or two items of numeric data should be presented in prose form. Often one or more tables is a good solution. Many people find tables confusing and difficult to understand (Wright 1968). Tables should be structured and compact for easy accessibility. Tables can be produced with or without markings for rows and/or columns. Columns should not be too far away from each other.

Tables that communicate the quantitative aspects of data are effective only when the data are arranged so that their meaning is obvious at a glance (Ehrenberg 1977). After deciding what data to present but before designing a table, we need to consider that (a) rounded-off values may display patterns and exceptions more clearly than precise values, (b) a reader can compare numbers down a col-

umn more easily than across a row, and (c) column and row averages can provide a visual focus that allows the reader to inspect the data easily.

Readers prefer vertically oriented tables where it is easy to see the target entries, and then quickly find the data in the table cells (Wright 1968; Wright & Fox 1972). Horizontally oriented tables are harder to use and more difficult to understand. According to Tinker (1963) the type used in tables should be no smaller than 8-point, and no larger than 12-point. Like pictures, all tables should be integrated with the text content, in the flow of text. In a text, tables should preferably be put between paragraphs, and not forced to break paragraphs and thus disturb the reading. The examples show how vertically and horizontally oriented tables look with different kinds of rulings. In the examples all tables provide the same “made-up” nonsense data. Thus, the data has no interest here. Usually a table-title tells us about the data presented in the table. This is, however, not the case in the following examples. Here the table-titles comment on the design of the table (Tables 4.1–4.3).

Table 4.1 Table titles are often put above the actual table in a table text with a description of the table content. This is a vertically oriented table. In this table the outside ruling is thick. The heading separator is thick. The first column ruling is medium thick. Other column and body row ruling in the table is thin.

Products	Sales in \$		
	1999	2000	2001
Product 1	120	130	140
Product 2	180	160	150
Product 3	220	200	210
Product 4	320	320	300
Product 5	420	440	450

Table 4.2 This is a horizontally oriented table. In this table all ruling is thin.

Sales in \$	Products				
	Product 1	Product 2	Product 3	Product 4	Product 5
1999	120	180	220	320	420
2000	130	160	200	320	440
2001	140	150	210	300	450

Table 4.3 This is a horizontally oriented table without any ruling.

Sales in \$	Products				
	Product 1	Product 2	Product 3	Product 4	Product 5
1999	120	180	220	320	420
2000	130	160	200	320	440
2001	140	150	210	300	450

Table 4.4 This vertically oriented table is not only ugly, it is also very confusing and provides poor legibility.

Products	Sales in \$		
	1999	2000	2001
Product 1	120	130	140
Product 2	180	160	150
Product 3	220	200	210
Product 4	320	320	300
Product 5	420	440	450

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

- All the information the learner will need should be presented in the table. That is, the learner should not be required to interpolate, combine entries, draw inferences, or otherwise manipulate the contents of the table in order to determine the correct answer. Rather, the learner should only be required to scan the list to find the correct target entry.
- Type size used in the table should be between 8 and 12 point.
- Items should be arranged vertically in the table rather than horizontally (i.e., the list of target entries should be vertical).
- Items within columns should be grouped and separated from other groups by either white space or rules (lines) in order to facilitate reading without accidentally moving to another row. Groups should contain no more than five items.
- Redundant abbreviations of units should not be included within the table entries [although they should be included in the column or row headings].
- ‘Landmarks’ or sub-headings – certain target entries in the table highlighted by using bold type or a larger font (e.g., every tenth entry, starting with 10, 20, 30, etc.) as an intended aid to locating entries – should not be used, since they appear to be ineffective and possibly confusing.
- It is useful to have adjacent columns printed in different fonts or styles to distinguish between them. That is, there is less chance of erroneous reading of the table if the column of target entries is in normal text (for example) and the column of associated answers is in boldface text.
- Related pairs of items in adjacent columns should be spaced closely together (i.e., the eyes should not have to traverse a great distance between the target entry and the associated answer).
- Whenever possible, columns should be arranged so that the target entries are to the left of the answers.

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

- Numbers should be rounded off to no more than two significant figures to facilitate learners' making comparisons.
- Averages of rows and columns (as appropriate) should be given to facilitate learners' making comparisons of individual cell entries to them.
- Put the most important comparisons into columns (rather than rows), as columns make for the easiest comparisons.
- Numbers in rows or columns should be arranged in some meaningful order whenever possible (e.g., increasing or decreasing).

4.3.9 Layout of text and pictures

A typical page in a telephone directory is almost filled with text. There are no pictures, and the margins are narrow. Here, the text may cover 90 percent of the page. In dictionaries the text covers 75–80 percent, and in specialist books and factual study books the text often covers 50–60 percent of the page. In pure literature and children's books, the text area is often even smaller than that. When a picture covers the entire page, there is no space for text or margins. The third extreme is an empty page. When texts and visuals are collected for informative pages and spreads, "message transmission" must be a central consideration. This kind of "information layout" differs from a "decoration layout" in which purely aesthetic aspects are allowed to predominate.

In newspaper layout many different messages have to be communicated. The problem is to communicate a series of disconnected messages of infinitely varying significance within a limited space, time, and economy with a recognizably consistent style for each section of the paper. Many readers will only spend time on a limited amount of information in a newspaper. It is known that elements like headlines, photos, drawings, and information graphics attract attention and often are entry points into a page. Size and placement of such elements influence how the reader will read a page. It is possible that many readers may jump over too large pictures and never look at them at all. In magazine layout visuals are often very large. Quite often the visuals have no or a very limited contact with the text. Here White (1987) asks for less typographic amusement and more serious character building. Fiction layout certainly does not work very well in instructional message design. However, even in non-fiction publishing, it is often very hard to access the information.

Picture placement has very often been based on aesthetic rather than instructional characteristics. The appearance of elements on the page can provide powerful cues to the reader. Thus, visuals should be located in close proximity to the

parts of the text in which pictured motifs are discussed. As previously noted visuals plus their legends should preferably be inserted into the text between two paragraphs, not in the middle of a paragraph, so they do not disrupt reading rhythm. Legends and visuals are often piled up in different areas and sometimes even on different pages. Here, an effort should really be made to achieve the best possible interplay of words and visuals. Visuals interact with the legends, other visuals, headings, running text, tables, and maps on a page and on a spread in a book, a magazine, or a newspaper. The layout of the whole spread should be attractive. However, the mere use of a lot of pictures is not at all enough. In an artistic layout, the message may actually be effectively hidden. The message is more effectively conveyed by an informative layout.

Harmony in typography will be achieved when there is good relationship between the individual elements in the design and the “wholeness”. A balanced typography gives an impression of quality and credibility. Contrast in typography may be achieved by using different fonts, styles, sizes and colours. The basics for message design could be summarized in the following: Select Arrangement, Balance and Colour to maximize Dynamism, Emphasis, Fidelity and Graphic Harmony.

In nature balance is normal. A design should usually display “good balance”. Elements of the design should fit together in an aesthetic and harmonious relationship in a manner which is interesting but not distracting. Man has an intuitive sense of balance. When a single element is too large or too small, too light or too dark, too prominent or too indistinct, the entire design will suffer from this imbalance. However, good balance is something subjective. Different people may have quite different opinions on any aesthetic issues. A composition is balanced when the visual weight of graphical elements on either side of the centre of balance are approximately equal. As with a physical balance, lighter elements can balance heavier elements if their size or value is increased, or if they are moved farther away from the centre of balance. It is also possible to move the heavier elements closer to the centre of balance. Mullet and Sano (1995:51) noted that altering even a single attribute of one part in a complex composition can have a significant impact on the balance, the unity, and ultimately the harmony of the whole.

Imbalance creates an uncomfortable feeling in the reader and should often be avoided. Imbalance, however, can be used to attract attention within a picture or within a material. Unexpected, irregular, and unstable design will attract attention. As soon as instability is introduced in a design the result is a provocative visual expression. The eye will struggle in order to analyse the relationships and the balance within the picture. Balance can be formal with total symmetry or informal. Formal balance is felt to be static and harmonious. Informal balance contributes to a feeling of dynamism. However, the mind needs stimulation and surprise. Contrast

and imbalance can dramatize a design and attract attention. Several artists use a visual strategy, such as combinations of dark and bright, large and small, round and square, to sharpen meaning. See also the section 3.3.8.2 *Balance in pictures*.

Several authors have noted that in materials for information a picture should be located as close to the relevant text passage as possible (Lidman & Lund 1972; MacDonald-Ross 1977; Hartley & Burnhill 1977a; Haber & Hershenson 1980; Wright 1982; Braden 1983; Benson 1985; Pettersson 1989).

4.4 Reading projected visuals

In audio-visual materials, such as slides, filmstrips, overhead transparencies, data- and videoprojections, lettering must be considered carefully. 15–20 words on a slide are maximum for effective communication. Letters should be medium to medium-bold. Lettering height should be no less than one 25th of the height of the artwork to be transferred. Generally speaking, lower-case letters are more legible than capitals. Slides and overhead transparencies should preferably be horizontally presented. In slides, the picture surface has a height-to-width ratio of 1:1.533, which is quite close to the golden mean (1:1,618). In overhead transparencies, the corresponding ratio is 1:1.289.

As previously noted the complete image is projected on the screen (Figure 4.14). For good legibility of projected text in a room with some light we should consider the following aspects:

- Projected images should preferably be horizontally presented.
- Text should have maximum legibility.

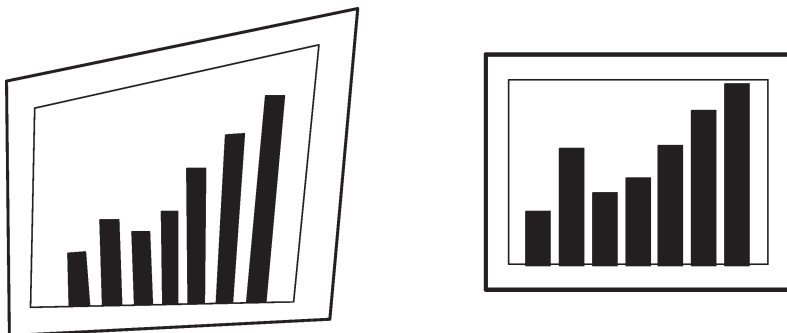


Figure 4.14 Distortion. This situation (left) is far too common when we use projected images. The same kind of problem with distortion may also occur in printing if we are not carefully handling the visuals. The second picture (right) is projected in a correct way.

- In overhead transparencies and computer aided presentations it may be a good idea to use a linear typeface such as Helvetica or Arial; for example 36 and 30 points for headings, 24 points for the body text, and 18 points for texts within illustrations.
- In 2x2" slides lettering height should be no less than one 25th of the height of the artwork to be transferred to film.
- Text must also be legible to spectators who are sitting at the rear of the hall. The minimum size of letters in overhead transparencies is six millimetre (Helvetica 18 points).
- Restrict stylized and fancy typefaces to opening slides.
- Use no more than six rows of six words each in one image. The line distance should consist of the size of the typeface plus 10 to 20% of extra white space.
- Edit the text into sections that are easily read.
- Be consistent in the use of uppercase and lowercase letters.
- Text should usually be left justified. Headings may be centre justified.
- Maintain a good contrast between foreground and background.
- Good colour combinations are yellow and black, and white and blue.
- White and yellow, red and green, and red and blue are all very bad colour combinations.
- Avoid graduated and tonal background fills.

As previously noted text images are a useful adjunct for a speaker but are sometimes very boring to an audience. In written documentation, this type of information should be worked into the body of the text instead. It is not enough that a slide is well-designed and have a high technical quality. It should also be projected and used in a correct way. Contrary to the use of overhead transparencies the slide's subjects should appear against a black background. When we want to use mounted slides or filmstrips the room must be properly darkened. The only exception is when equipment is available for back projection, i.e., projection from the rear onto a matte-glass screen. Text slides should only be used to a limited degree. Texts should be light (white or yellow) on a dark background (black or dark blue). Many colour combinations are hard or even impossible to read on a screen.

4.5 Reading on screens

Compared with traditional graphic presentations, a presentation of information on visual displays such as television sets and computer terminals is very limited. Still, information may be presented in many different ways. Visual displays can be built in many ways. A colour television set, an advanced computer terminal, and a liquid crystal display all have different characteristics. A television set is built

to be watched at a distance of more than 120 centimetre. A computer terminal, however, is built to be used at a distance of 60 centimetre and has a much better picture resolution than a television set. Our perception of text and pictures on visual displays are, of course, to a large extent dependent on the quality of the screen. A videotex terminal simply cannot reproduce a simple illustration like a pie chart, since the resolution is only a total of about 5,000 graphical elements.

Computer terminals are often built with a screen resolution of 72–82 dots per inch. An ordinary television image consists of about 250,000 image point, or picture elements, which vary with respect to both grey scale and colour information. High Definition Television (HDTV) uses 1,125 scanning lines and can contain five or six times more information than the present NTSC standard colour television system, with 525 lines. (The European PAL-system has 625 lines.) HDTV developments of flat PAL 625 screens will also give increased technical possibilities to present text and pictures. Visual displays will continue to have a resolution far below a printed page. Some laser printers produce documents with 1,200 dots per inch horizontally, and 600 dots per inch vertically. Photo-typesetters produce 1,250–2,600 dots per inch. This is enough to create small and close raster dots and to produce fine lines in the final print.

As noted earlier, the body text in a book should be set between nine and twelve point. The corresponding range of font sizes are 15–20 points for reading text on a computer terminal, and 90–120 points on a 24" television set. The legibility of the text depends on the execution of the individual character and the possibility for each character to be distinguished from all the others. The characters may vary with respect to font, size, lower-case and upper-case letters, colour, and contrast to the background. Knave (1983) provided guidelines for legible characters. A minimum of ten to twelve raster lines per character is required. When characters are built by dots in a dot matrix, the characters will be round or square, and not elongated. A dot matrix of seven by nine dots is often regarded as a minimum. The height of the characters should be a minimum of four millimetre for a viewing distance of 60 centimetre.

Due to the relatively poor resolution on visual displays and television sets, we should avoid typefaces with very thin lines for texts intended to be read on these screens. A typeface without thin lines and serifs, like Helvetica, is available in most programs for desktop publishing. In 14 point Helvetica, upper-case letters are approximately four millimetre, corresponding with the minimum character size in accordance with Knave (op. cit.). Some typefaces, like Chicago, Geneva, Lucida, and Verdana have been specially designed with respect to the resolution of computer screens and have a good legibility even in ten and twelve point type. However, these typefaces are not always at hand.

General design rules should be employed also in the design of screen displays with information that is intended to be read on the screen rather than printed on paper. Thus, material should be arranged and displayed so that it is easy to read: from top to bottom and from the left to the right. A visual display design may vary with respect to spatial organisation, like headings, length of lines, justification, spacing, number of columns, number of colours on the same “page” or in the same “window”, and directive cues, like colour coding, twinkling characters or words, and scrolling text. Experiments (Pettersson et al. 1984) with 11,000 individual judgments of perceived reading efforts of text on visual displays were concluded as follows:

- Colours presented on colour displays seem to be ranked in the same order as surface colours in traditional print media. Blue was most popular.
- When text is shown on a visual display, there is no easily-read colour combination.
- The best text colour is black, which causes good contrast to most background colours.
- The best combination is black text on a white or yellow background.
- A text can be easy to read in any colour, provided that the background is carefully selected.
- The best background colour is black, which has good contrast to most text colours.
- Reading efforts of colour combinations are independent of the gender of the subjects.
- There was no difference between colour blind (red – green) users and users with normal vision.

Inverse writing in various colours within a text may be used to achieve emphasis. Other possibilities may be a box around a paragraph or a change in font or size of letters. The *background* may vary with respect to colour and brightness. Good combinations of text and background colours always have a good contrast. Optimum contrast is often found to be 8:1 to 10:1. Most subjects prefer a positive image, that is, dark text on light background with a minimum refresh rate of 70 Hz.

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

However, colour as well as blank space on a visual display are essentially free and might be used to increase legibility and readability.

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

CHAPTER 5

Cognition

Understanding and learning is maximized when the content is the same in visual, audio, and print channels. The content, the execution, the context, and the format of a learning material influence the viewer's ability to perceive its message. We need to apply and use what we learn. Knowledge is internalized, and made our property as part of our memory. Learning is affected by many different factors, also by the presentation of information. Thus information design is important for learning. In writing of the learning objectives it is an advantage to use verbs that denote observable behaviour.

In this chapter the main focus is on the receiver, and how the receiver may understand information and learning materials. We can assume that there is more than one learning process involved while we are learning, and that we are using different processes for learning in different situations. According to Carlson (1993) a large and growing body of evidence indicates that we can learn without being aware that we have done so.

Theorists do not all agree about what learning is and how it comes about. Over the years that scholars have been interested in the processes of learning, many elaborate theories of learning have been developed and tested. Some researchers are trying to develop one single comprehensive learning theory encompassing all kinds of learning. However, as far as I know, no such attempt has been successful. Uljens (1992) noted that there is no theory of learning that is widely accepted. Thus we have to deal with a large number of theories and models of learning, and learning processes – each useful in its own context. It is obvious that learning is affected by many different factors, also by the *presentation of the information*. Thus information design is important for learning. I prefer to view learning and learning theories from a *process perspective* rather than from a traditional *outcome perspective*. Attention, perception, processing, and application are the basis for the “mental model of learning” that I call “The Learning Helix” (Pettersson 1995).

5.1 Attention

Pashler (1995) noted that a task that is given full attention is accomplished quickly and efficiently. Attention is ordinarily under the control of our “will”, although

other stimuli may sometimes grab our attention despite efforts to prevent this from happening. In my view, learning processes start with attention, such as curiosity, excitement, expectation, or fear. In pedagogy this is called motivation. Among the thousands of stimuli in the external context we see, hear, smell, feel, taste, or pay attention to, and select one stimulus at a time. Attention is sudden, direct, and distinct. The sequential flow of attention to the parts of a message is determined by the sequence in which information is presented to us.

In accordance with Key (1977), the average adult in the USA is exposed to over 500 advertising messages daily, of which he or she consciously perceives around 75. Today, there are probably even more messages. There are always far more stimuli than we can ever notice in any given situation. Most stimuli remain unknown, unseen, and unheard of. Attention, or mental preparedness and receptiveness, can be considered as the activation of groups of brain cells that contain previously recorded experiences, or knowledge.

5.1.1 Senses

Sense organs are important in understanding and learning because they are the only way that we can record and observe the world outside our own bodies. If we are aware of the limitations and defects of our senses we can make better decisions about the accuracy of what is happening. Smell, taste, and feeling are very important senses in natural life, but they are not yet especially important factors to be considered when we want to use information conveyed in messages that are distributed with various media. Only aural and visual impressions will be the subjects of a discussion here.

5.1.1.1 *Hearing*

Sound is a subjective sensation of hearing, i.e., the sensory cells in the inner ear's hearing apparatus are stimulated. In objective terms, sound consists of longitudinal wave motions capable of acting on our hearing apparatus and thereby eliciting sound sensations. Man is normally capable of perceiving sound waves at frequencies from 16 to 20,000 Hz. Sound waves lower than 16 Hz are referred to as infrasound, and frequencies higher than 20,000 Hz are referred to as ultrasound.

Sound pressure waves make the ear drum vibrate (Figure 5.1). The vibration is passed on to the ossicles, the three small bones in the middle ear. The movements of the third bone, the stirrup, against the membrane in the oval window create changes in pressure in a fluid within the cochlea, the inner ear. This fluid causes a basilar membrane to flex back and forth. The auditory cells are located on this membrane. These cells cause the neurones of the auditory nerve to send signals to

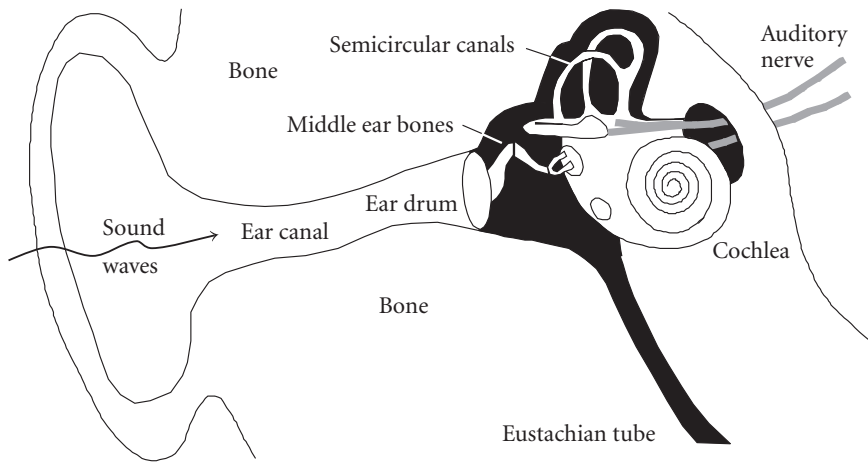


Figure 5.1 Hearing. Sound waves are transmitted from the eardrum via the middle ear bones (hammer, anvil, and stirrup) to the inner ear. When the stirrup pushes against the membrane in the oval window the round window bulges outward. Sound vibrations cause flexing of different portions of a membrane in the cochlea where the receptive cells are located. The semicircular canals belong to our sense of balance.

the brain for processing. Different frequency sounds are perceived when different parts of the basilar membrane vibrate in response to these frequencies.

Sound intensity, i.e., the average rate of sound energy transmitted per unit of time and unit area which passes a plane perpendicular to the transmission direction, is an objective measure of sound intensity. It is usually measured in W/m^2 (watts per square meter). However, a psychologically based concept is necessary in order to designate the strength of sound waves striking our ears. The hearing range is the interval between the lowest sound intensity we are capable of perceiving, i.e., the auditory threshold, and the highest level we are able to tolerate, i.e., the pain threshold.

5.1.1.2 Vision

Vision operates at the level of overt behaviour that enables organisms to avoid predators, find food, find mates, and move around from one place to another in their environments. In subjective terms vision is a complex process which elicits a sense of vision, i.e., awareness of the stimulation of the eye's vision perception cells. In objective terms, light consists of electromagnetic waves (light "rays") capable of acting on our eyes and creating sensations of light and images. Human vision is sensitive within a wide wavelength range (Figure 5.2). Visible light ranges from wavelengths of 400 nanometers, nm, (or 0.0004 millimetres) that is violet, to 770 nm, that is dark red. In between these extremes are blue, green, yellow, and orange.

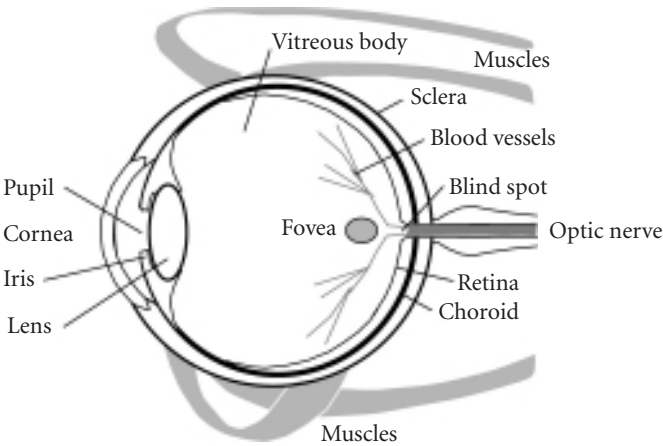


Figure 5.2 Vision. A cross section of the human eye.

Green-orange (about 555 nm) lies in the region of the eye’s greatest sensitivity. Sensitivity decreases markedly toward the red and violet ends of the spectrum.

Like sound waves, light waves are propagated in straight lines from their source. They can also be reflected, refracted, bent, and absorbed. The velocity of light in air is nearly 300,000 km/s. When light rays (usually parallel) from an object enter the eye, they are refracted in the cornea and lens and pass through the vitreous humour until they strike the retina. When the ambient light level is high, the light rays strike the macula lutea, the fovea, a small area of the retina which is rich in cones. Cones are the receptors which record colours. The classical view is that each sensory organ picks up individual sensory impressions which are interpreted more or less individually. The retina’s receptors are excited by light and respond by chemically converting a pigment, rhodopsin (visual purple). This conversion triggers impulses which are transmitted along the optic nerve and the thalamus to the brain’s primary visual cortex. This takes only a few milliseconds. In the visual cortex the impulses are translated into a sensation of vision.

The optic nerve has about one million optic nerve fibres leading from the ganglion cells. In the fovea there is an almost one-to-one connection between cones and fibres, whereas as many as 600 rods may be connected to one optic nerve fibre in the outer periphery of the retina. This helps to explain why visual acuity is best in the fovea. When light rays from an object are bent in the cornea and lens, an upside-down image of that object is formed on the retina. Very small children view the world as being upside-down. After a time, however, the brain somehow learns to process retinal images so that they are perceived to be right-side-up. According to Nakayama et al. (1995) vision is an extremely complex process. About half of the cerebral cortex may be engaged in processing of visual information.

Different parts of the visual field have their exact counterparts in the visual cortex. Nakayama et al. (1995) wrote (p. 4):

By painstakingly recording from one nerve cell at a time, neurophysiologists have pieced together an unusually detailed account of how neurons respond to visual input at various stages of the visual pathway – from the photoreceptors, to the visual cortex, and beyond. Not surprisingly, photoreceptors are sensitive to just a small localized part of the visual field, responding only when light is presented in this very small region.

The primary visual cortex is organized into some 2,500 rectangular areas, called “tiles”. Each tile consists of a block of tissue, approximately 0.5 x 0.7 mm with some 150,000 neurons (Carlson 1993). Each tile receives information only from a small part of the retina. In the tiles neural circuits analyse information about movement, depth, orientation and width of lines and edges, and also colour. Information from each tile is then sent to all sub-regions of the first level of the nearby visual association cortex. The second level of the visual association cortex in the temporal lobe receives information about orientation and width of lines and edges as well as colours for perception of three-dimensional shapes and colours of objects. The second level of the visual association cortex in the parietal lobe receives information about depth and movement. Here this information is combined with information about movements of the eyes, the head and the body for spatial perception of location and movements of objects.

Since we have two eyes, both pointing forward and with partially overlapping visual fields, we can assess the distance, both forward and laterally, between objects (Figure 5.3). It takes a certain amount of time for the eye to record light rays from an object, such as a painting. And it also takes time before we are capable

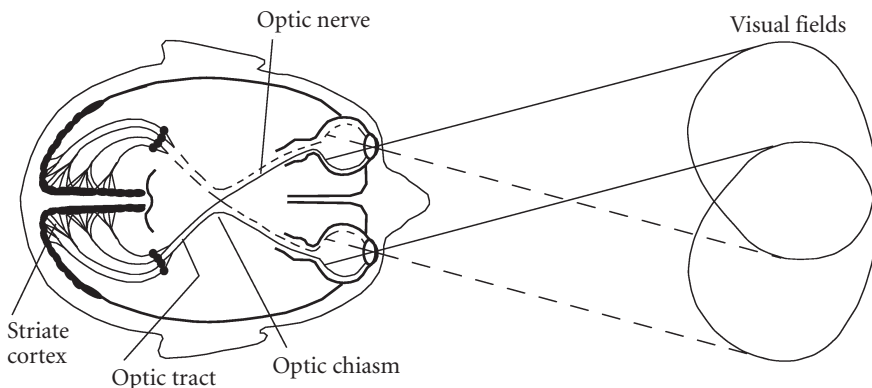


Figure 5.3 Optic pathways. Illustration of the optic pathways, showing partial crossing of optic nerve fibres at chiasm. Information from each eye reaches both halves of the brain.

of perceiving that object as an image. The eye has inertia. This inertia enables us to perceive motion. When we look at a person who is walking or running, the eye records a series of stills which ultimately blend into one another and form a moving image. This inertia also enables us to see motion in the stills which comprise a movie film or a TV image. Nowadays, however, sensory organs are often described as sensory systems and the total energy flux striking them viewed as information about the surrounding world and about ourselves. The individual sensory organs receiving this information are not merely passive receptors but jointly constitute an active, exploratory system in which all the senses intimately interact into coherent perception.

According to Gibson (1966) the eye does not really operate like a camera. We are never conscious of the “stills” formed on the retina. We only perceive the external world they represent. The eye and head shift their attention constantly from one point to another. Our vision is an active, exploratory process. We usually concentrate our attention to interesting events within a narrow segment of our total field of vision. Eyes never remain still. They tremble at a frequency of about 30–90 Hz. This serves to shift information of individual cells. The eye alters its fixation point constantly. It also makes constant small jumps. We constantly “scan” the things we look at.

By using complex instrumentation that allows the researcher to record exactly where in a picture a person is looking at any given moment, it is possible to study the way in which the gaze wanders over a picture, pauses and fixes on certain points (see Pettersson 1993, for an overview). The gaze never fixes on most parts of a picture (Figure 5.4). Only certain image elements capture our attention.

Yarbus (1967) found that fixation usually lasts for two to eight tenths of a second and that eye movements between eye fixations took from one to eight-hundredths of a second. We normally view a picture by means of a large number of eye movements and eye fixations in rapid succession.

The location of each fixation influences how a picture is interpreted and later remembered (Nelson & Loftus 1980). Yarbus (1967) found that instructions given prior to viewing determined what segments of the picture received the most attention. The pattern of eye movements and fixations is entirely different when our objective is to search for something in a picture. The things we wish to see in a picture have a major impact on the location of eye fixations. Where we look and why we look there determines what we see. Global to local scanning means that we notice the overall structure or figure first and then the details or informative areas. We quickly find out which details of a picture are the most informative ones and then we concentrate our attention to those parts.

A number of scientists have found that pictures which are hard to interpret require more eye fixations than “easy” pictures. Wolf (1970) determined that “dif-

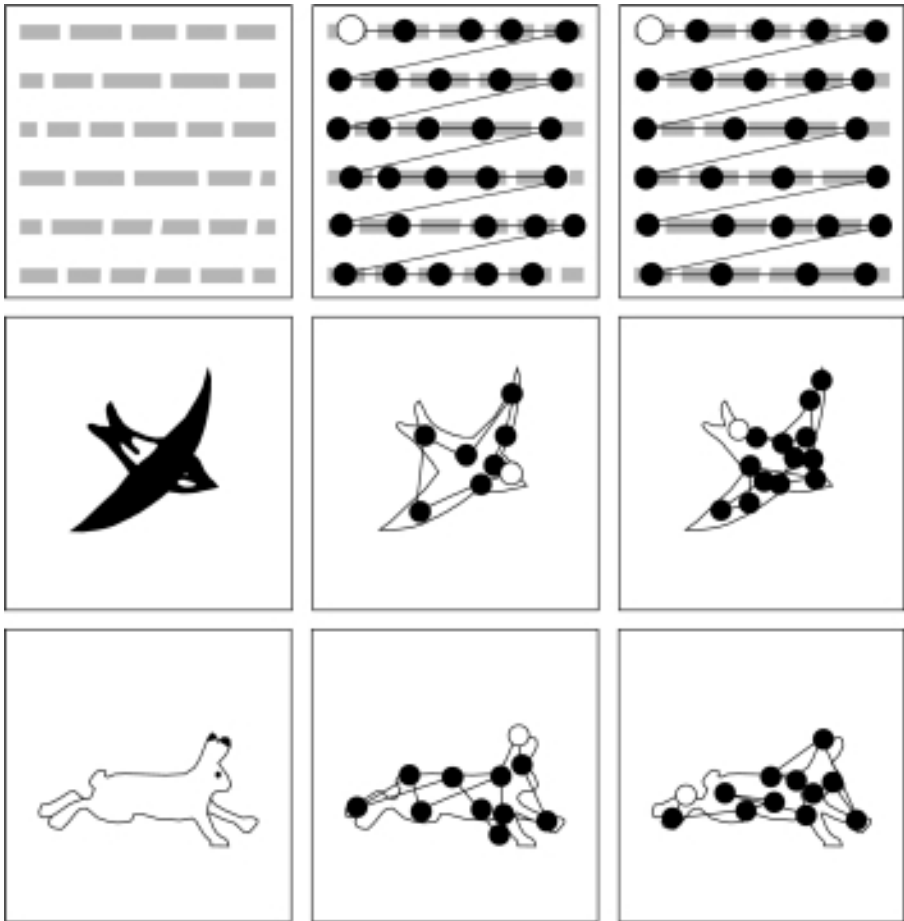


Figure 5.4 Eye fixations. Examples of eye fixations by different subjects on a text and on two simple drawings. Each fixation takes about 1/5 of a second. It takes only a few seconds for adult subjects to recognize and “label” the content in a simple picture. Some parts of a picture are never “seen”. In each case the white circle is the place for the first fixation.

difficult” pictures require more fixations up to a certain point. When a picture was extremely difficult, subjects tended to avoid looking at it or searched for a visual centre. However, neither Baron (1980) nor Nesbit (1981) found any correlation between picture type and the number of fixations. But the two latter scientists did employ a different method in their studies than the authors mentioned previously.

Movement or change in a picture or an event attracts our attention and therefore causes many fixations. Hubel and Wiesel (1962) found that many sensory cells in vision responded only very weakly to uniform light but very vigorously to changes in light intensity. This principle also applies to other sensory cells, i.e., the

cells respond primarily to change. Sensory cells are also quickly exhausted. Acuity falls rapidly outside of the fovea. However, some information can be processed from peripheral vision. The gist of a picture can be understood after only a few fixations. Gibson (1966), Moray (1970), and many of their successors (e.g., Edwards & Coolkasian 1974) feel that movements detected in peripheral parts of our visual field automatically cause the eyeball to shift position to permit fixation of these movements.

It is possible for us to see the difference between several million colour stimuli at simultaneous viewing. However, if not being seen simultaneously, the number we can identify is much smaller, maybe 10,000–20,000. It has been assumed that our perception of colours is a two-sided phenomenon. The discrimination capability represents our possibility to differentiate a figure from its background. It is strongly influenced by and dependent on contextual variables such as lighting conditions and other surrounding colours. The colour identification capacity on the other hand makes us capable of interpreting “the quality” of the object we perceive. “Colour constancy” is a tendency to judge objects as the same despite changes in illumination. It can be concluded that our attention will not last for long. A visual material and a presentation must constantly redraw the attention to hold the interest of the viewer.

Guba et al. (1964), Gould (1973), and Nesbit (1981) found a positive correlation between eye movements and intelligence. Highly intelligent subjects utilized more fixations than less intelligent subjects. Wolf (1970) discovered that highly intelligent subjects displayed great flexibility in their “scanning patterns”, irrespective of the stimuli, whereas subjects with low intelligence tended to display a static scanning pattern which was the same for different stimuli. Nesbit (1981) found a positive correlation between learning and the number of fixations. Wolf (1970) suggested that eye movements can be employed as an index of visual learning. Eye movements supply information on where, how long, and how often subjects look at different parts of a picture.

Looking at pictures is a “natural” way of free exploring. However, reading a text needs to be very structured with several eye fixations on each line. The time for each fixation varies among individuals and different texts (Ekwall 1977), with the average time for good readers between 1/4 to 1/6 of a second. It also takes from 1/25 to 1/30 of a second for the eye to move from one fixation to the next and sweep from the end of one line to the beginning of the next. In normal reading the text within foveal vision comprises an area of seven to ten letter spaces. At normal reading the angle of convergence is about 2°. This means a reading speed of five to ten words per second or 300–600 words per minute. Lawson (1968) has established the physiological limit of reading as being a maximum of 720 words per minute. Ekwall (1977) calculated the maximum reading speed of the most efficient reader

as being 864 words per minute under ideal conditions. Speed and eye movements during reading are dependent on the reader's perceived informativeness of the text.

The importance of eye movements can be summarized in the following five points:

1. Only certain image elements attract our interest.
2. The pattern for eye movements and fixations depends on what we wish to see or are told to see in a picture.
3. Informative parts of a picture attract more fixations than less informative parts.
4. Different kinds of pictures give rise to different kinds of fixations and intelligence and visual learning.
5. There is a positive correlation between the number of fixations and intelligence and visual learning.

5.1.2 Frames of reference

Every day we are bombarded with information via the media: at home, in school, at work, and in the society in general. It is hard to avoid information, and it is just as hard to obtain the information that we really need. It is possible that we miss the information that we are interested in. We always have a "frame of reference". New impressions are dependent on and interpreted against the background of our previous experience and learning, our attitudes and interests, our needs and feelings, and the prevailing situation. Attention is never objective – it is always subjective. We direct our attention to things that move; are large, bold, and clear; are new; have bright colour, an unusual shape, or a good contrast; and that deviate from the surroundings or from familiar patterns. We direct our attention to contents that arouse feelings and needs. This is frequently used in advertising and propaganda in various media. Keates (1982) noted that discriminatory responses to map symbols depend on contrast in form, dimension, and colour. We direct our attention to what we happen to be interested in at the moment.

Our attention will not last for long. A visual material and a presentation must constantly *redraw the attention to hold the interest* of the viewer. A presentation holds the viewer's attention when the rhythm, layout, and pace are not predictable and boring. When people turn on their television set they might not be interested in the programme. In Japan, television-viewing habits were recorded for participants in the Hi-OVIS project (Matsushita 1988). During the first 30 seconds, people sometimes switched between 15–20 different channels. Thus, people only spent one to two seconds viewing the television image and deciding if the programme was interesting or not. Viewers do not take the time to actually listen to the sound. Their decisions are based on the pictorial style and contents. According to Bieder-

man (1995) people can usually interpret the meaning of a novel scene on television from a 100-millisecond exposure to it. Commissioned by the Director's Guild in honour of its 50th anniversary (1986), the film "Precious Images" was a gift to the American movie audiences. This short consists of a 6.5-minute assemblage of classic moments from 469 favourite movies – past and present. Some moments linger for a few seconds but many are as short as eight frames (1/3 of a second), averaging 20 frames (less than a second). It is a strange experience to see this film. The carefully chosen images retain their meaning and emotional impact, and trigger your memory.

All cognitive tasks place demands on a pool of limited cognitive resources. When a task imposes a heavy load on the cognitive system, it will in turn interfere with learning by misdirecting attention and limiting remaining resources that are necessary for construction of knowledge (Sweller et al. 1990). Clements (1984) concluded that "the attentional process is relatively diffuse" (p. 146). Wickens (1980, 1984, 1991), and Klapp and Netick (1988) have suggested a multiple resource model of attention and processing. Resource models based on individually allocated pools of resources have been developed to explain the effects of structural alteration and time sharing that cannot be effectively explained by other attention models, such as structural theories and capacity theories.

Researchers in the areas of instructional message design, visual literacy, and visual communication have found that the most common functions of visuals concern *attention*: attract, gain, get, hold and maintain attention are mentioned. In accordance with Brody (1982), preference for a particular visual format does not necessarily result in increased learning. Yet, in the absence of more substantial data, information based on student preference has a meaningful role to play, in affecting learning from information materials and instructional texts. All other things being equal, we should provide formats that are *preferred by the viewer*, thus making the text more attractive – and hopefully – more motivating. However, in practice this is often not possible.

An effective, systematic, colour code in a learning material assists the learner in organizing and categorizing stimuli into meaningful patterns. However, it should be remembered that anomalies of colour vision, is a condition in which certain colour discriminations cannot be made. "Colour blindness" is much more common among men than women, with estimates ranging as high as 8–10% of the male population. Only 1% of the female population has anomalous colour vision. The failure to distinguish between red and green is most common. Unfortunately, red and green are quite often used as discriminating symbols.

5.2 Perception

Traditionally *experience* is divided into two categories: sensation and perception. *Sensation* is thought to be a lower-level function. It is often defined as the awareness of simple properties of stimuli, such as brightness, coldness, colour, warmth or sweetness. *Perception* is thought to be a function of higher-order areas of the brain. It is the *awareness* of more complex characteristics of stimuli. According to tradition we have five senses, but in fact we have more. Sensory organs jointly constitute a perceptual system that collects an enormous amount of superfluous information about this environment. The sensory system normally supplies us with exhaustive, unambiguous intelligence about events occurring there.

We are often unaware of the sensory channel(s) supplying us with information. We are merely aware of the external events, events that appear to be absolutely real and unambiguous. In unnatural, artificial surroundings, the brain often “translates” sensory stimuli, in an attempt to relate them to its stored information, memories, about more familiar places, events, and times. We are capable of successfully smelling, tasting, feeling, hearing and seeing things at the same time. We are also capable of simultaneously hearing different stimuli in either ear. However, we are probably incapable of simultaneously perceiving different stimuli aimed at the right and left eye, respectively. A stimulus may easily be perceived in different ways at different times.

5.2.1 The perception processes

We live in a tree-dimensional world, full of sounds, fragrances and odours, light and shadows, events and objects resting on various surfaces. As visual creatures we rely on reflected light to obtain information from the visual world. The concept “perception” is a collective designation for the different processes in which an organism obtains information about this outside world. Perception is the organizing and analysing of the information that we pay attention to. We unconsciously make a constant effort to create some order in the impulses. We rely on our senses to provide us with data about the outside world. Points, lines, areas, symbols, colours, tones, noise, heat, cold, touch, pressure, sound, visuals, text, are integrated in such a way that they can be interpreted as a meaningful whole. We do not see patches of colours and shades of brightness. We see *things*, like books, magazines, cars, cats, dogs, horses, flowers, people, and trees.

We rely on our experiences, thoughts, and values to interpret, understand, and create meaning from what we see, hear, taste, touch, and smell. We have so much information coming from the outside world that we cannot pay attention to all of it. In the torrent of information that bombards us, we have to *select* the informa-

tion we want to see or hear and we ignore the rest of the information. 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”. When we attend to something we select that information for further mental processing.

In view of our limited capacity for handling simultaneous information (Miller 1956), it is important to find out which factors determine the parts of the available information that will be processed. Which stimuli do we select and why? When we first look at a visual, we only see what is necessary to perceive and identify objects and events in a reasonable and meaningful manner. This is Gibson’s “principle of economy” (Gibson 1966).

The perception process is often assumed to consist of two stages or levels. Information processing is automatic, unconscious, tentative, fast, rough, and parallel in the first stage (Sinatra 1986). It comprises all kinds of analysis, from physiological to cognitive processes. Different properties of a stimulus are identified simultaneously. Often one analysis is sufficient. The second stage of the information analysis is conscious, it demands attention, and it is detailed and sequential. Various hypotheses about a stimulus are weighed against one another, and tested. Information processing is more definite at this level.

According to Nakayama et al. (1995) surfaces of shapes constitute the only visually accessible aspects of our world. We cannot, for example, obtain visual information from the interior parts of ordinary objects. However, often object surfaces occlude other surfaces. Nakayama et al. argued that the visual system must develop an internal representation of the scene as a set of surfaces as a prerequisite for further mental analysis. They argued that image-based representations are insufficient bases for higher-level vision. Nakayama et al. showed that adopting a few simple rules makes surface representation comprehensible (p. 10).

Rule 1. When image regions corresponding to different surfaces meet, only one region can “own” the border between them.

Rule 2. Under conditions of surface opacity, a border is owned by the region that is coded as being in front.

Rule 3. A region that does not own a border is effectively unbounded. Unbounded regions can connect to other unbounded regions to form larger surfaces completing behind.

Fleming and Levie (1978) noted over 50 principles, and Winn (1993) listed more than 75 principles related to perception. While intended for the instructional designer, these principles are also useful to the information designer, as well as the individual learners. The goal for these lists of principles is to create better and more accurate perception, avoid misperceptions, and help designers to create different kinds of messages. Perception is not an absolute and objective process. It is subjective, and varies as a result of a number of factors, like the learner’s current cultural

and social status, the time and stage of his or her development, mood, experience, memory, and other cognitive processes.

Individuals differ in the ways that they perceive any given stimulus. One person may perceive a stimulus and quickly assimilate it. Another person may not assimilate that stimulus at all. Human perception is only sensitive to changes in stimulation. You actually perceive *less* than all you see and hear, and much information is never used. At the same time you may perceive *more* than you see and hear. You may believe that you see and hear things that are not there. Your brain fills in missing information. Accurate identification can be made from the correct perception of just a few parts.

The perception system strives to obtain clarity. If the system arrives at clarity, then clarity serves as a reinforcement, a reward. So, our perception of a text or of any image depends on our previous experience, our mood, other pictures, texts and sound, as well as our personal interests. When we look at a visual, we also “see” different details in the visual on different occasions. Consequently, a highly “saturated”, information-packed message, like a picture, may have something new to offer even after having been viewed many times.

5.2.2 Perception “laws”

Many psychologists view our attempts to establish order as an innate faculty carried out in accordance with certain “laws” or principles. Perception is always organized. We perceptually construct relationships, groupings, objects, events, words, and people. We see dots, lines, areas, light, dark, etc., in an organized way. One of the most simple perceptual organizations is that of “figure and background”, or “figure and ground”. Some elements in a visual are selected as the figure (Figure 5.5). The remaining elements constitute the background. This is the “theory of



Figure 5.5 Figure and ground. In the illustration to the left we easily recognize a square as a “figure” against the dotted background. In the other illustration, the properties of “figure and background” cannot be sharply distinguished. The two squares are of the same size with straight sides.

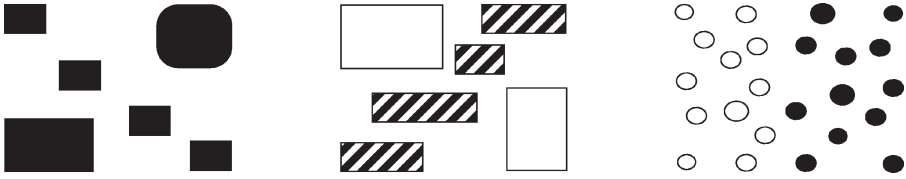


Figure 5.6 The “similarity law”. We tend to group elements that look alike. Here, it is easy to see the similarity of size and shape (left), the similarity of texture (middle), and the similarity of value (right).

figure/ground”. Some structures will be perceived as reversible when it is hard to choose between figure and background. Reality and what we see at any given moment will always be separated and different. We will see different things at different occasions.

According to the *principle of area* a small shape within a large shape will be interpreted as the “figure”, while the larger shape is interpreted as the ground. Our ability to distinguish the boundaries of an image is usually very high. All elements in a visual should contribute to clarity, the visual should be meaningful to the intended audience.

“Good figures” are closed and exhibit a continuous contour. A given contour can belong to only one of the two areas it encloses and shapes. Whichever side, the contour shapes will be perceived as a figure. Reversible figures lack sufficient cues as to which side of a contour is figure and which is the background. This is often used to create illusions. We may all have seen a reversible figure that is perceived as a vase or as two heads facing each other.

The *context* in which a visual message is presented is important for the way the message is perceived. For example, the context may consist of text, speech, music, sound effects, or other visuals. Our attention is on either the sound or on the image when we view a film or a television programme. 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. It is impossible for viewers not to be influenced by the movement. In *camouflage* the intention is to make a figure as much like the background as possible. *Information design* is the opposite.

In accordance with the “theory of similarity” or the “similarity law”, we tend to group impressions on the basis of their similarity. Objects sharing similar characteristics, such as colour, orientation, pattern, shape, size, texture, value are seen together and belong together (Figure 5.6). One black sheep in a flock of white sheep tends to be noticed. This can be used for emphasis of specific parts in a message.

Most figures are defined by a boundary. However, the presence of a boundary is not required for the perception of form or shape. When small elements are ar-

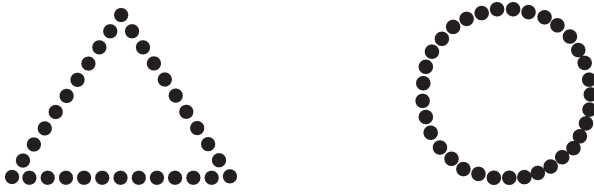


Figure 5.7 Grouping. Groups of smaller elements may be perceived as larger figures.



Figure 5.8 The “proximity law”. Here we may see four pairs of dots instead of just eight individual dots. Perception is organized.

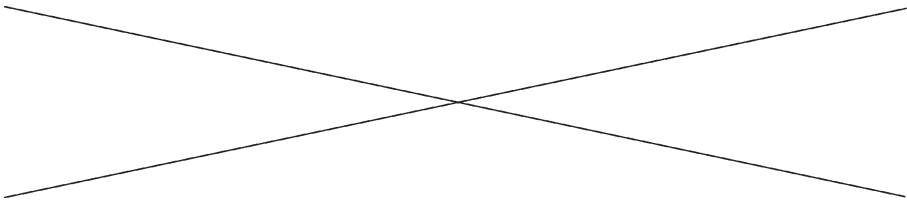


Figure 5.9 The “continuity law”. We see this pattern as two lines crossing in the middle rather than as two (or even four) opposing angles joined together at their apexes. This is also referred to as “line of direction”. Perception is selective.

ranged in groups, we tend to perceive them as larger forms (Figure 5.7). This is similar to “closure.”

The “proximity law”, tells that we group objects and events on the basis of their proximity to one another (Figure 5.8). Objects near each other belong together. The eye tends to be attracted to groups or clusters rather than to isolates. Perception is organized.

The “continuity law”, “good continuity”, or “theory of direction”, tells that we perceive a slow and gradual change in a stimulus as one single stimulus (Figure 5.9). It is easier to perceive a smooth continuation than an abrupt shift of direction. Lines moving in the same direction belong together. Events that have a simple and natural relationship to one another also give the impression of being continuous and unbroken. Straight or curved lines tend to lead the eye along, and even beyond, the line. An arrow or a finger pointed at something leads your eye to it.

In accordance with the “theory of closure” or the “natural law”, various stimuli form meaningful patterns. If a figure is incomplete, our minds will fill in the missing parts and “close” the outline of the figure. For instance, letters printed with damaged or broken type are typically seen as perfect or whole characters, and it may be hard to proof-read a text. A single dot on a paper has strong visual power to



Figure 5.10 The “natural law” or closure. We have a need to make “wholes of units”. Two dots suggest a line. Three dots suggest a triangle. Four dots may suggest a square. We see the pattern to the far right as one circle partially occluded by another. Even though there are many possibilities, this interpretation seems to be the natural one. This is the *principle of good form*. Here perception is influenced by expectations.



Figure 5.11 The “contrast law”. A line (a) seems to be long when it is compared with a shorter line (b), but short when it is compared with a longer line (c). Perception is relative.

attract our attention. Two or more dots connect, and are capable of leading the eye. Dots create the illusion of lines and areas (Figure 5.10). Perception is influenced by our expectations.

The “common fate law”, tells that objects grouped in a particular way will be expected to change in conformance with this grouping. When change does not follow this pattern, the change is difficult to process. In their natural environment many animals are camouflaged with colour, spots, and stripes. Thus their shapes and boundaries are obscured. As long as these animals remain still they are well hidden because we can not distinguish figure from background. Once the animals move their shapes may be perceived.

The “objective set law” tells that some states are perceived more strongly than others. For example, two lines that almost form a right angle are perceived as a right angle. The “contrast law”, tells that we tend to array impressions that form natural opposites, thereby reinforcing one another, in groups (Figure 5.11). We interpret the information from our sense organs with a bias towards constancy.

Usually, there is a *constancy* of size, shape, colour, brightness, and contrast in the perception of known objects. This is regardless of distance, angle, and illumination. When we see cars on various distances we still believe that they have some similarity. New impressions are dependent on and interpreted against the background of our individual previous experiences and learning. Our experiences and our assessments change over time and affect our way of associating. We sometimes perceive only what we want to perceive. It is easy to jump to the wrong conclusions. Messages that are contradictory often create more confusion than they provide help.

M N Z K M N M K Z E K N M M K M Z E M Z
M N Z K M N M K Z E K N M M K M Z E M Z

Figure 5.12 Selective perception. The letter “N” is difficult to locate in the upper row because here all the characters have the same size, colour, and value. In the bottom row the perception of “N” is easier since this character is set in bold type.

5.2.3 Perceptual qualities

Bertin (1983, 1989) provided a survey of “retinal variables” which are suggested to be perceived immediately and effortlessly “above” the picture plane and across the entire visual field. According to Bertin visual contrasts must be established by manipulating the perceptual qualities of size, value, hue, orientation, texture, shape, and position. These variables can all be manipulated to structure and enhance the experience of an image, a package, an environment, and a man-machine graphical user interface. Bertin’s taxonomy considers four styles of perception: associative, selective, ordered, and quantitative perception.

In *associative perception* the reader ignores variation on one visual dimension when reading a picture. A visual variable is *associative* when it does not influence our perception of other dimensions in the visual variables. A visual variable is *dissociative* when it severely influence our perception dimensions in the visual variables.

In *selective perception* the reader isolates instances of a specific category from other visual elements (Figure 5.12). This is the opposite to the principle of similarity. The task is to ignore everything but one specific value of one specific dimension.

In *ordered perception* the reader must see the relative ordering of values along a perceptual dimension. Size, position and value are variables that are ordered. Objects can easily be arranged objectively from least to greatest. This is often used in diagrams.

In *quantitative perception* the reader must be able to determine the amount of difference between ordered visual elements. It is easy to estimate the difference in length between lines. However, it is hard to compare areas and even more difficult to compare volumes.

Preble and Preble (1989) noted that “everyday visual perception” is a continuous flow of complex interrelations. Visual elements have a conceptual relationship. Organizing a message can make perception much easier and learning more efficient. The message should have a moderate degree of complexity. However, complexity without order produces confusion, and order without complexity may produce boredom. Inappropriate use of graphical elements may direct learner at-

tention away from essential learning cues, and depress subsequent achievement. It can be concluded that our perception varies as a result of a number of factors, such as cultural and social status, the time and stage of our development, our mood, experience, memory, and other cognitive processes.

5.2.3.1 *Perception of colour and shape*

The relationship between colour and shape as stimuli has been studied by many researchers. Otto and Askov (1968) found that the importance of these stimuli is related to the respective subject's level of development. For small children (three to six years), colour stimuli have greater impact than shape stimuli. However, the reverse is true of older children i.e., shape becomes more important than colour. Modreski and Gross (1972) found that four-year-olds were better at pairing objects by shape than by colour. Ward and Naus (1973) studied pre-school children and found that they were also better at identifying objects by their shape than by their colour. MacBeth (1974) found that children from three to eight emphatically tended to sort coloured paper by shape rather than by colour, so shape is often more important to children than colour. According to Keates (1982) the term shape is reserved for the spatial arrangement of geographical features. The apparently equivalent term "form" can only be applied directly to point or line symbols on maps. Form is an element in identification, whereas shape leads to recognition.

For discriminating of colours on maps, Keates (1982) found that three factors are important. In the first place, for hues which have a high lightness value (such as yellow) only a few differences in saturation are apparent. Conversely, for a dark blue or red, a larger number of perceptible differences can be made between maximum saturation and a neutral grey of the same value. Second, the perceptible differences in value (lightness) and chroma (saturation) are not symmetrical for different hues. In the third place, the ability to discriminate between different saturations of the same hue is strongly affected by the area of the image and by spatial separation. Fine discriminations in saturation and lightness are only possible if there are no other colour distractions. If other colour elements, such as lines crossing the areas, are introduced, then the ability to distinguish slight differences in saturation or lightness is decreased.

5.2.3.2 *Perception of depth*

The illusion of depth is created when our brains interpret the slightly different views from our two eyes. Convergence also provides important information about depth. When the eyes converge on a nearby object, the angle between them is greater than when the eyes converge on a distant object. Based on the angle the brain calculates the distances to the objects. The *stereoscope*, and the *Viewmaster*, presents two slightly different two-dimensional photographs. When the pho-

tographs are viewed simultaneously by the eyes, the brain merges the two images to one combined three-dimensional image. The stereoscope was very popular during the later half of the last century as a source for education and entertainment. *Stereocards* viewed through stereoscopes were the main source of pictorial news. Even though most pictures are presented on a two-dimensional plane or flat surface with a length and width, we expect them to have the illusion of depth, a third dimension. When we look at a still picture, or view a motion picture, *time* can be seen as a fourth dimension. People will employ their individual viewing behaviour, and see and interpret different messages in the same picture.

Depth is related to size, volume, weight, and mass. Spatial perception is not the perception of space as such but of the learned meaning of the relationship between different objects seen in space. The perception of depth is related to the relative size of known objects, to lighting conditions, to illumination and shadows, to judicious croppings, to linear perspective, to change of line weight, to texture gradients in the picture, to upward angular location of grounded objects, to interposition and overlap of picture elements, and to filled and empty space. Image elements conveying a sense of depth should be clear and easy to comprehend. Depth perception is also based on the different colours' of varying wavelengths. Warmer colours emphasize a foreground, and cooler colours emphasize a background.

The spatial perspectives are important for our perception of depth. Compared with visual language factors like space, size, colour, lighting, and texture, the spatial perspectives are usually complex depth cues. A person's cultural heritage and social situation is always of vital importance for the perception of depth cues. Painters and photographers often use *several* different types of perspectives to enhance the effect of depth in their pictures. Line perspectives, aerial perspectives, colour perspectives, and overlapping perspectives may well be used at the same time to interact with each other and create lifelike pictures that are good representations of reality. However, for schematic pictures that are meant to show three-dimensionality in technical and scientific illustrations, it is usually more appropriate to use only one of the different perspectives at the same time.

Elaborating the cues for our perception of colour, shape, and depth are common in illusions. Some familiar examples of illusions are presented on the following pages.

5.2.3.3 *Illusions*

One and the same stimulus can easily be perceived in different ways on different occasions. A famous example of this is the Necker cube (Figure 5.13). It is perceived in one of two ways. There are many examples of "transformation" pictures of this kind. Some artists have become specialists in making pictures which can be perceived in different ways. When the brain analyses new data, it automatically

adds or subtracts information in an effort to obtain a “sensible” interpretation of that data.

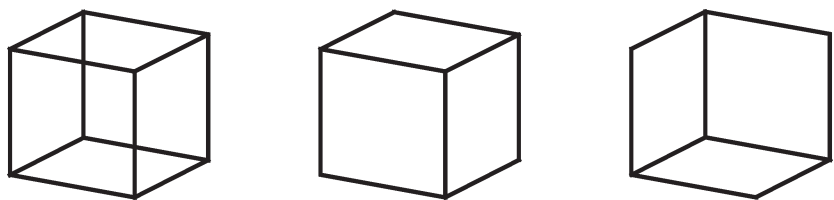


Figure 5.13 The Necker cube. The Necker cube left and the two ways we can perceive it.

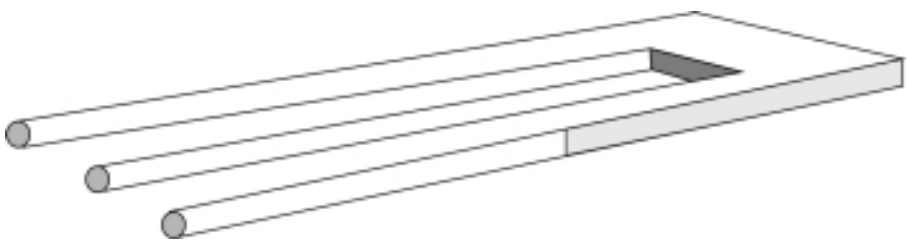


Figure 5.14 An “impossible” figure. This figure is “impossible”. The depth ambiguity means that the eye is unable to obtain all the information necessary to locate all the figure’s parts. The brain becomes unable to determine how to interpret the image.

word

Figure 5.15 Fast interpretation. We often think we see things which are not really there. The black marks here are interpreted by many viewers as forming the word “word”. An illiterate person would be unable to interpret the marks as forming a word.



Figure 5.16 Lines. We often have difficulty in interpreting simple relationships. For example, horizontal lines are often perceived as being shorter than equally long vertical lines.



Figure 5.17 Light and dark. Open and light forms are perceived as being larger than closed and darker forms of the same shape.

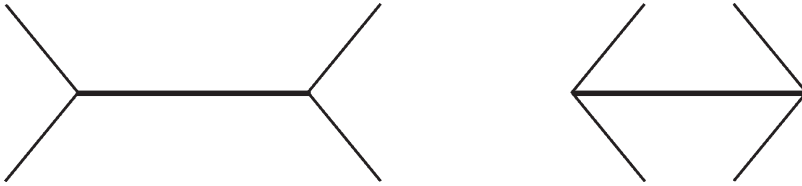


Figure 5.18 Müller-Lyer's illusion. The left figure seems to have a longer horizontal line than the right figure.

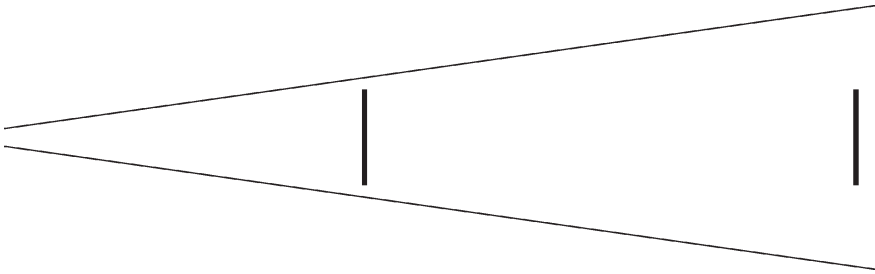


Figure 5.19 Ponzio's illusion. The left vertical line seems to be longer than the right vertical line.

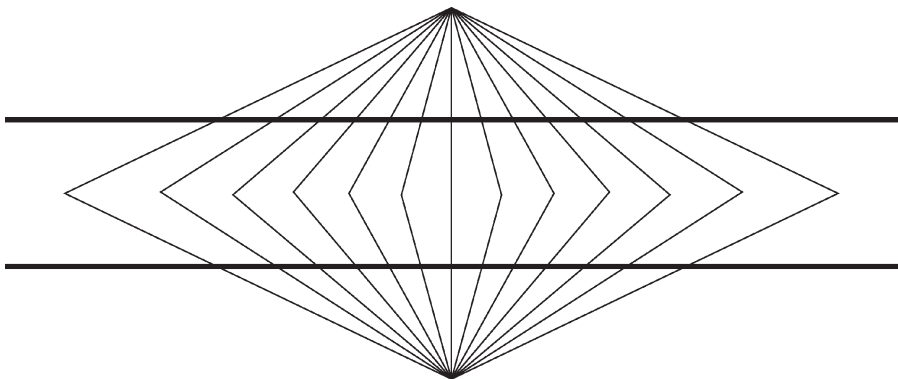


Figure 5.20 Wundt's illusion. Intersected straight lines no longer appear to be straight but bent or serrated.

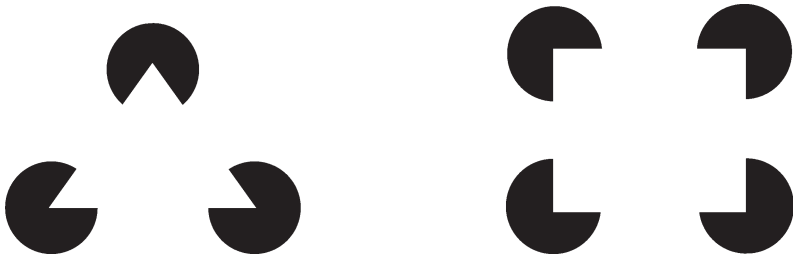


Figure 5.21 Kaniza's illusion. Our brains can create a contour where non exists in the image. Kaniza (1979) describes such illusory contours as examples of *modal*, or *visible* completions.

5.2.4 Picture perception

Three-dimensional images, like sculptures, can be viewed from almost an infinite number of points, not just front, back, and two sides, but 360° vertically, horizontally, and all the points in between. When we look at sculptures, we create our own individual impressions and perceptions. A single sculpture, made by one of the great masters, is like a rich encyclopedia of aesthetic experience. We can look endlessly at Michelangelo's "Rondanini Pietà", Rodin's "The Thinker", or Moore's "Reclining Figure", and find many new aspects to appreciate. It is also known from several experiments that also two-dimensional images are perceived in many different ways by various subjects (Pettersson 1985, 1986). Even simple line drawings evoke many associations. Vogel et al. (1986) showed that image-enhancement intended to improve interpretation of image content sometimes got in the way of the message. They concluded that image-enhancement graphics should be used selectively and carefully. When in doubt, they recommended, plain text should be used. Limburg (1987) pointed out that receivers have even more ambiguity or semantic diversity with visual images than with most expressions of written language with its manifold meanings. Lodding (1983) reported on the problems with misinterpretations of icons used in computer systems. However, he concluded that people find a naturalness in dealing with images either as an aid to or, in some circumstances, as the sole means of communicating.

In several experiments subjects have been given different assignments. Thus subjects have been asked to name image contents, to describe image contents, to index image contents, to write legends, to assess image contents, to create images, to complete a story, to illustrate a story, to produce informative materials, to produce information graphics and to describe picture context. Results from these experiments, based on more than 77,000 verbal and visual statements from 2,500 subjects, confirm the theory of a dual stage perception. It is suggested

that different assignments cause perception and image interpretation on different cognitive levels.

There are many approaches to picture perception. Based on the theory of linear perspective, invented during the Renaissance, Gibson (1971) defined picture perception as a stimulus-driven process in which information is picked up from optical arrays. The opposite view is held by Gombrich (1969) and Gregory (1978). While seeing a picture the viewer constructs a meaning based on experience and expectations. From this receptionist position neither the readers nor the message remains the same. Meaning exists only for a moment within each individual reader. Another approach to picture perception is based on semiotics and symbol theory (Goodman 1976). Intentionalism suggests that meaning is embedded in the message by a producer, leaving the reader to discover and unfold it. From this perspective meaning exists independent from the reader. For an intentionalist a painting means what the artist says it does. For a receptionist the painting does not mean anything until the reader says it does (Muffoletto 1987).

Boeckman (1987) makes a clear distinction between drawings and paintings, which have “signs” and photographs which have “recorded perceptual stimuli”. Before photography was invented there were two modes to learn about reality. Perception processing stimuli of the surrounding reality on the one hand and communication processing signs on the other. Now we have something in between: “Recorded perception stimuli which are not reality but not signs either”. For Arnheim (1974) picture perception is a matter of responding to basic forms such as gestalt laws. An important point of Arnheim’s is that visual perception includes the same behaviours that we commonly consider only as matters of cognition or thinking. A “percept” is a building block of visual thinking and as such is analogous to the cognitive function of a concept. Some researchers suggest that information is represented solely in the form of propositions. Images are said to be recorded into propositional format by a series of transformations (Pylyshyn 1973, 1979). Others suggest more complex systems in which a variety of storage formats co-exist in an interlinked manner (Anderson 1978, 1983; Wender 1989). With respect to the use of visuals for information Pettersson (1993) concluded that:

- All visual experience is subject to individual interpretation.
- Perceived image content is different from intended image content.
- Different assignments may cause different interpretations of image contents.
- Some assignments cause interpretation of image contents on a low and some on a high cognitive level.
- Even simple pictures may cause many different associations.
- A given set of basic elements can be combined to form completely different images.

- The design of a picture can be changed a great deal without any major impact on the perception of the image contents.
- Content is more important than execution or form.
- Picture readability is positively correlated with both aesthetic ratings and assessed usefulness in teaching.
- Legends 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.
- There seems to be no major difference between gender in interpretation of image contents.
- Students display poor pictorial capabilities.
- Most subjects have their own ideas on how to finish a story.
- There are major differences between intended and perceived levels of quality in informative materials.
- We must learn to read image content.
- How we actually create meaning needs more research.
- Guidelines to visual artists will usually not lead to destruction of creativity.

5.2.5 Pictorial style preferences

Sloan (1971) discussed four pictorial artistic styles: (1) photographic, (2) representational, (3) expressionistic, and (4) cartoon style. Photographic style was defined as a coloured photograph of the subject. Representational style was defined as an artist's rendition of the subject which conforms to the subject in its true form. Expressionistic style was an artist's rendition of the subject which leans heavily towards abstraction. Cartoon style was defined as an animated caricature of the subject. These four artistic pictorial styles form a realistic to an abstract continuum.

The literature on preferences for pictorial artistic styles fall into three primary groups (1) studies in which subjects selected a preferred picture from a series of pictures, in isolation from any accompanying text, (2) studies in which subjects selected a picture which they felt best illustrated accompanying text, and (3) studies in which subjects were asked to supply verbal reasons for their picture preferences. Several researchers have concluded that children preferred realistic art styles. However, Ramsey (1982) concluded that primary age children preferred photographic as well as cartoon art styles, when they selected pictures in isolation from text.

In one study (Pettersson 1990) teachers as well as children regarded colour photographs showing what things look like, drawings as complements to photographs, authentic, historical pictures, and authentic pictures of works of art as examples of "good visuals". "Fussy" overviews, abstract, obscure, ambiguous pic-

tures, or pictures lacking the necessary facts were regarded examples of “poor visuals”. Poor visuals may display prejudice against gender, sex stereotyping, or groups of people, and attitudes in conflict with democratic principles. Pictures with merely a decorative function and “educational cartoons” were other examples of poor visuals.

Like Sloan (1971) and Lucas (1977), Ramsey (1989) concluded that children equate highly realistic art styles (photographic and representational) with text content which depicts reality and real-life situations. Ramsey also found that children were very consistent in equating the more abstract art styles (expressionistic and cartoon) with imaginative, “pretend” or “make-believe” literature. According to Ramsey (1989), children like to read about real-world subjects illustrated with full-colour photographs, and they like to read about imaginative subjects illustrated with cartoons. This research suggests a complex interaction between children’s perceptions of artistic style and their selection of style to accompany specific literary forms. Ramsey suggested that children employ pictorial artistic style as a yardstick for measuring the reality or fantasy of accompanying content material. Artistic styles may give children various “pre-understandings” of the text contents. It is important for the designer to live up to these expectations.

5.3 Processing

Metallinos (1997) noted that attentional and perceptual processes are neurophysiological and basic biological activities of the sensory organs and the nervous system. All cognitive processes are mental activities. He concluded that in perception we see, hear, and taste fragmented bits of information. In cognition we see, hear, and taste cohesive and unified information. Perception and thinking are activities that take place where no one can see them – inside our heads. Carlson (1993) pointed out that because thinking is hidden, we can only infer its existence from people’s behaviour. When we think, we perceive, classify, manipulate, and combine data and information. When we are through, we know something that we did not know before. Much of our thinking involves verbal language. We use words and concepts, but we also think in colours, shapes and images.

The modern era of brain research began in the mid-1960’s, when Dr. Roger Sperry and his associates published their findings regarding patients who were operated on to control life-threatening epileptic seizures (see Gazzaniga and Le Doux 1978; Wilson, Reeves, & Gazzaniga 1982; and Sinatra 1986; Levie 1987, for reviews). In accordance with some theories, the two halves of the brain are apparently specialized and function independently of one another. At the same time, however, either of the brain halves appears to be capable of assuming the functions

of the other half. There is an immense communication between the two halves of the brain. It has been estimated at six billion pulses per second. Each half of the brain has its own sensory perceptions, thoughts, feelings, and memories. The left half of the brain is said to be mainly verbal: capable of speech, counting, and writing. It seems to be specialized in abstract thought. It is analytical, logical, detailed, and sequential. The right half of the brain is said to be speechless but it is capable of concrete thought, perception of space, and can understand complicated relationships. It is also said to be holistic, spatial, intuitive, and creative. Most certainly, there is considerable cooperation between the two brain hemispheres. Generally speaking, dual and parallel processing modes are beneficial.

During processing of information, new groups of brain cells are activated and associate to each other (Dryden & Vos 1994). Old and new information is processed in an attempt to find possible relationships or *gestalts*. Information is gradually converted into experience, insight and knowledge. Later, knowledge is converted into skills and attitudes – and eventually into wisdom. The knowledge acquires more detail and is internalized. This process is influenced by our earlier *experiences and memories* (our internal context). The brain has 100 billion brain cells (neurons) and 900 billion supporting glia cells. Each neuron may be connected to other brain cells via more than 20,000 structures called synapses. The brain cells communicate with each other by transmitting electrical impulses through this gigantic network, which is constantly changed and adopted to new situations.

Many estimates have been made of brain capacity. It has been said that the number of possible connections between the brain cells are greater than the number of molecules in the universe. According to Cotton (1995a) all those gloomy predictions that our brain cells have been decaying from the moment we were born have been refuted in some current research which suggests that brain cells can regenerate and that nerve cells can certainly grow again to give sensation to limbs which have been without sensitivity.

The brain is sometimes described as a living jungle, far more advanced than any machine ever developed. However, the “cognitive science” approach compares the human mind with computers. Cognitive scientists generally model the human memory as a very complex network, where each piece of data is cross-linked, or cross-indexed, to many other pieces of data in many different places. Computers and computer networks are now being built to mimic this complicated arrangement.

5.3.1 See–look–read

Texts and pictures may be either easy or difficult to interpret, depending on different factors. If, for example, a reader lacks the background knowledge in a given

field that is required in order for him to interpret a text, then there is no chance that he will understand it, no matter how diligently the writers, instructors, graphics experts, and designers exert themselves. The same applies if the reader's command of the language used is poor.

Salomon (1984) pointed out that there is a widespread naive preconception about pictures as "easy media". Most people are convinced that pictures require only a small amount of invested mental effort to be understood. Weidenmann (1988) pointed out that a learner may quickly get an illusion of full understanding of the content or message in an image, and may stop the information processing after only a short glance. When the picture is combined with a text, he or she will concentrate on the part of the message that is perceived as the more informative. Text is generally perceived as a better medium than film for communication of to-be-learned content (Katz, Blumler, & Gurevitch 1974; Kosbiech 1976; Salomon 1984). Weidenmann (1988) suggested that similar preconceptions may also exist about text vs. printed pictures.

A single fixation of a picture is sufficient to enable us to recognize it later among other pictures. If we go shopping in a department store, we are virtually unaware of the large number of advertising messages and background music to which we are exposed to in the store. Everything merges into a kind of "noise". We probably only process most of the stimuli in this noise on a superficial level. We see and hear but do not look or listen. When we listen to the radio while engaged in some other simultaneous activity, such as cooking a meal, fixing a punctured tire, or glancing through a newspaper, we are aware of words, music, and images.

Looking at a picture consumes more mental energy and demands a higher cognitive level than merely seeing a picture. Visual impressions are conducted from the sensory to the short-term memory. We only become aware of the information which succeeds in passing through the brain's filtering system. Most of the information disappears after a while. When we, e.g., study material in books or on TV, we process that material actively. We read texts, listen to music, and read pictures. Perceived information is processed, sorted, and stored in certain parts of the brain's long-term memory.

Many fixations of a picture are required for people to recall it subsequently and, e.g., be able to describe it. Conscious analysis of linguistic messages, such as texts, music, and pictures, probably demands an even greater consumption of mental energy and a higher cognitive level. The brain uses about one fifth of our daily consumption of energy. The most demanding processes are those leading to the creation of text, music, and pictures. Creative people have often described the mental effort which is often associated with creativity. The model assumes the existence of a dynamic relationship in which we consciously and unconsciously switch cognitive levels.

Our sensory organs respond to changes in our environment. We are normally capable of resolving changes with a gradient greater than about two percent. But we adapt to slow, gradual changes and often fail to notice them. Our senses are normally in the resting state but have a rapid response capability. In the corresponding manner, we are unable to remain on the highest cognitive levels for more than relatively brief periods of time, since this would otherwise be too enervating and lead to some form of mental “cramp”.

No clear distinctions can be made between the cognitive levels discussed here. There are probably major differences between individuals due to cultural, social, and personal factors. However, the model can be employed to elucidate the fact that there are major differences between the concepts “see-look-read” and “hear-listen”. Active reception of linguistic intelligence comprising text, sound, or pictures, individually or in concert, always requires exertion. Reading and listening are mentally and physically exhausting. In my view, the sender of a message should strive to design text, music, and pictures in the most attractive, relevant manner possible so receivers are encouraged to process the message on the highest possible cognitive level.

Compared to a book, audiovisual media may have a highly manipulative effect on receivers. Message contents change continuously with respect to subject selection, time, and space. The receiver’s active efforts to seek information are therefore largely disabled. A reader can “digest” the contents of a book at a self-selected pace. In a structured information context, the reader is able to process information in about the same way as in a “natural” situation. Pictures have much greater ability to influence us than a text. Children are more easily frightened by watching an act of violence on TV than by reading about the same act in a book. This is because things we see appear to be more “real” than things we merely read about and because a higher cognitive level is required for reading than for seeing. Just as we learn to read texts, we can also learn to “read” pictures. Tailoring pictorial language in all media is therefore essential so the degree of “reading” difficulty increases progressively in, e.g., school textbooks.

To take active part in a linguistic message that consists of text, sound, or pictures – either together or separately, always implies the exertion of effort, that is, work. Reading or listening taxes our faculties; sooner or later we become tired. Furthermore, material that is poorly constructed and presented strikes us as dull, and not only causes our interest in the subject to wane, but leaves us exhausted. This applies irrespective of whether a message is meant to impart information, instruction, or entertainment. It also applies irrespective of the medium of conveyance, except in so far as different media have entirely different capacities for conveying a message from a sender to a receiver.

5.3.2 Memories

Linsday and Norman (1977) stated that in the teaching-learning environment, “the problem in learning new information is not getting information into memory; it is making sure that it will be found later when it is needed” (p. 337). One thing that is common to all the phases of the analysis performed on incoming information is the need to store the signals for varying lengths of time, so that the information processing can be carried out. In psychological terms, the processes that carry out this information storage are referred to as “memories”. We have “memories” rather than one single “memory”. Various researchers have used different terms for the different memories. On the basis of the length of time that memories last, Bloom et al. (1985) noted that there are three kinds of memories: (1) immediate memory, (2) short-term memory, and (3) long-term memory.

5.3.2.1 *Sensory memory*

There are many models seeking to explain the function of our memories (see Sinatra 1986; Levie 1987, for reviews). One way of viewing memory functions is based on *information processing in several steps*. 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. Hearing a sentence, a word, or even a syllable requires the listener to integrate a changing pattern of auditory stimulation. This integration demands some form of short, temporary buffer storage, and it is likely that perception relies heavily on such temporary memory stores that holds a representation of the initial sounds until the entire word has been heard.

Another example of the sensory memory is the biochemical processes in the eye. The visual cells there possess some inertia and, therefore, function as a kind of memory. The sensory memory normally stores information for half a second to one second. Loftus, Shimamura, and Johnson (1985) showed that for one tenth of a second as much information can be extracted from this sensory memory icon as from the picture itself. The *iconic memory* (vision) and the *echoic memory* (hearing) are closely related to the sensory memory. These memories precede the integration of signals from various sensory systems. The function of the sensory memory appears to be to hold onto information long enough for it to be transferred to the next form, the short-term memory.

5.3.2.2 *Short-term memory*

After being processed in the iconic and the echoic memories, some information is passed on to the *short-term memory* (STM), *operative memory*, or *working memory*. Here it is only retained briefly, not more than one to two seconds (see Sinatra 1986; Levie 1987, for reviews). A number of complex operations are carried out during problem solving. The short-term memory has severe capacity limitations. Most

people can repeat a seven, or eight, digit telephone number, but not ten or eleven digits (without grouping them). Reading texts and pictures, and active listening, depend on our short-term memory, as does all mental activity.

Only a limited amount of information can be contained in the short-term memory at any one time. New information replaces information that is older than about a second, and the older information easily disappears if we are not prepared to store it in our long-term memory. If we repeat the information a few times, we increase our chances of remembering it. Long, complex words and sentences are difficult to understand. If the functions of the individual words in a text are not immediately apparent to us, our short-term memory becomes overloaded with long chains of words that cannot be directly put into a meaningful context.

Information that has entered the short-term memory can proceed through a filter that selects the information to be passed on to the long term memory. Once this filtration has taken place and certain information units have been assigned priority over others, these priority units are given access to a “register” with a limited memory capacity. This is when a person becomes aware of the stored information. All other non-priority information disappears, normally forever if it is not re-transmitted to the filter when the filter is able to accept the traffic. The filter scrutinizes the information received from the outside world and identifies the specific properties of this information. When the information involves aural signals, the filter notes whether the signal is strong or weak. When visual signals are involved, the signal is scrutinized for information on for example colour, size, direction, and movement.

According to Weinstein and Mayer (1986), rehearsal strategies are designed to repeat information while it is in the short-term memory to compensate for the time and limitations there. The longer an individual can rehearse information, take notes, analyse and interact with texts and visuals in an active way, the greater is the possibility that this information will be moved from the short-term memory to the long term memory and that increase in retention will occur (Murray & Mosberg 1982).

5.3.2.3 *Long-term memory*

The information that passes the “register” can be stored in a *long-term memory* (LTM). This is what normally happens with the knowledge we do not need for the moment. This long-term memory then sets the rules for the selection filter, so that the filter makes selections related to previous experience (see Sinatra 1986; Levie 1987, for reviews). The long-term memory has *episodic memories* of specific things we have done, seen, heard, felt, tasted, and so on. They are tied to specific contexts. *Semantic memories* consist of conceptual information such as our knowledge of the names of birds and flowers. Information is processed and re-

membered in chunks that are organized hierarchically. We have to think about and work with new information in order to get it into our long-term memory. Learning requires brainwork. According to Carlson (1993) long-term memory appears to consist of physical changes in the brain – probably within the sensory and motor association cortexes.

According to Branch and Bloom (1995) visual information is usually retained longer in memory than verbal information. The short-term and long-term memories are actually theoretical models that cannot be related to any activity pattern or any particular anatomical structure in the human brain. The distinction made between the STM and LTM is probably too clear-cut. Information can also be passed on to an “output system”, which emits signals to the muscles that are to carry out a given act. The information can be switched back from the “register” to the reception or to the short-term memory. Beaver (1994) claimed that visual memory is very fast. It is one thousand times faster to view an inner image than to rehearse a word from verbal memory. In accordance with Kosslyn (1975), more details of a mental image of an object are remembered when the object is imagined next to a smaller object.

Genres, prototypes and mental schemata are used in communication (Höijer 1992a, 1992b; Bondebjerg 1994). Long-term memory comprises schemata, organized networks of related knowledge that permit the human being to represent reality, and to act upon this cognitive representation (Rumelhart 1981; Sinatra 1986). These shemata are made up of relationships or operations, or both, and of variables. Each schema provides slots into which new knowledge is placed. Schemata are constantly refreshed and restructured through new knowledge, while additional connections among related schemata are made. For competencies to be acquired, it is essential that the learner brings the important elements of knowledge required by the task.

5.3.2.4 Other memory models

On the basis of the functions that memories perform they seem to be either (a) procedural, or (b) declarative (Pines 1986). *Procedural memory*, or *implicit memory*, is the memory for skills that are automatic, like driving a car. It is our unconscious memory which is capable of controlling rather complex behaviours. *Declarative memory*, or *explicit memory*, is the memory for facts, the memory of which we are aware. We know that we have learned something, and we can discuss this with others. These memory systems were the basis for development of the behavioural and the cognitive schools of learning.

Comparisons are sometimes made between the human brain and a serial computer. However, the brain differs in many ways from a computer. As a rule, a computer must be able to process considerably more information than a human in

any given situation, since most computer programs are unable to distinguish between important and unimportant information. Usually the machine is therefore incapable of ignoring any information in the way that the human brain constantly does. This is one of the reasons why a person's ability to process sensory information is far beyond the capability of even giant computers, even though the individual processing steps are carried out much faster in a computer than in the human brain, about one million times faster.

In accordance with the *cue information theory* (Adams & Chambers 1962), information that is shared between channels facilitates learning. Cues that occur simultaneously in auditory and visual channels are likely to be better recalled than those presented in one channel only. Drew and Grimes (1985) showed that close coordination between audio and video improved audio recall of television news and that redundancy improved story understanding.

The *dual-code memory model* (Paivio 1971, 1978) proposes a verbal system for processing and storing linguistic information and a separate non-verbal system for spatial information and mental imagery. These systems can function independently, but are also interconnected. According to Paivio (1983, 1986, 1991), the image is centrally important in facilitating long-term retention, at least for adults. Paivio (1983) showed that our memory for pictures is superior to our memory for words. This is called the *pictorial superiority effect*.

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. The redundancy in memory that results from this "dual coding" (Paivio 1971, 1983) or "conjoint retention" (Kulhavy, Lee, & Caterino 1985; Schwartz 1988) means that information can be retrieved either from the pictorial or from the verbal memory. It is also known that our memory for a picture-word combination is superior to our memory for words alone, or our memory for pictures alone (Haber & Myers 1982).

According to Klatzky (1980) dual-code theorists accept 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 subpictures 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.

Under ideal conditions, mental imagery has been demonstrated to be effective as an aid to learning of prose. Pressley (1977) found that when eight-year-olds were instructed on forming mental images, given practice at imaging, and were provided separate times for reading and imaging (as opposed to simultane-

ous reading/imaging), their memory of story content was significantly improved. Early studies established that when learners are told how to process visual information, their performance improves (e.g. Levin et al. 1974). Several studies confirm the finding that imagery strategies particularly aid poor readers and poor learners (Levin 1973).

Using visuals to complement texts is an effective rehearsal strategy in facilitating learner achievements (Dwyer 1978, 1985). Visual rehearsal allows the learner to process information simultaneously at several levels. Rehearsal activity provided to students significantly influenced the performance of students (Dwyer 1994). Pictorial representation of information has a tendency to reduce learner dependence on verbal comprehension skills. Other memory models include a *single-code memory model approach*.

As previously noted pictures can have a positive, a neutral, or a negative effect on learning (Levin et al., 1987; Sims-Knight 1992; Winn 1993; Rieber 1994). In conclusion, results from several experiments show that when the contents are the same in visual, audio, and print channels, learning is maximized. The content, the structure, the context, and the format of a visual influence the viewer's ability to perceive its message.

5.4 Learning from representations

Verbal languages have digital codification with combinations of letters or numbers, or both, representing content (Elkind 1975). There is no direct correspondence between groups of letters, words, and reality. Each meaning is defined and must be learned. In contrast to this, non-verbal languages have analogical codification with combinations of basic graphical elements (dots, lines, areas, and volumes) for likeness of a (concrete) reality (Pettersson 1983). Usually, there is a correspondence with reality. Visuals are iconic. They normally resemble what they represent. The meaning is apparent on a basic level but must be learned for deeper understanding. Gombrich (1969) argues that no pictorial image gains the status of a "statement", unless an explicit reference is made to what it is supposed to represent. Barthes (1977) used the term "anchorage" to describe the relationship of pictures to legends or other accompanying verbal language. Most pictures are capable of several interpretations until anchored to one by a legend.

5.4.1 Learning from text

In the USA the average person speaks about 135 words per minute (Judson 1972) and the fastest professional television or radio announcers speak about 150 to 160

words per minute. Reading is much faster. Our top reading speed is some 720 words per minute (Lawson 1968). Text, spoken and written, is always linear and must be processed sequentially – word by word. In printed text we learn from static lines that are dictated by the technology of the printing press. It is a common fact that reading or listening to a text with long sentences, many difficult and infrequent words, abstract concepts and a high number of adjectives and adverbs impede comprehension.

5.4.1.1 *Reading*

Reading is an important means of learning about our environment. The more a person reads, the more the reading skills improve. Several researchers, however, have reported that large amounts of text cause eye fatigue (Bradshaw 2000). Depending on the purpose, we can read a text in several ways. An active reader makes good use of the structure embedded in the book and in the text. The preface, the table of contents, the headings, as well as the captions and the illustrations provide an overview of the content in the whole book. Gunnarsson (1982) discussed five different categories of *reading objectives*. What differentiates them is the kind of stored knowledge that must be invoked before any understanding takes place. These five categories are not distinctly delimited; they partly overlap:

1. In memorization of the textual surface, the objective is to create a visual memory of the surface of the text.
2. In registration of the content as such of the text, the objective is to understand the structural and conventional importance of the written message.
3. In comprehension of the sender's description of reality, the objective is to understand what the sender means by the text.
4. In integration of the text into one's perception of one's own surroundings, the objective is to integrate the text into one's own earlier experiences and observations.
5. In direct, action-related comprehension, the objective is to know how one should behave in different situations, based on what the text says.

The first objective involves reading in order to recognize each word and memorize the text surface, while the second requires us to read and understand the words in the text. With objectives three to five, reading is directed towards individual sentences, parts and the whole of the text, and other proficiencies and ideas are brought to bear on the material. Objective three, for example, obliges the readers to interpret the text in terms of the sender's situation. Objectives four and five require that they interpret the text in terms of their own surroundings and world view. Möijer (1987) stated that we read in different ways, depending on the purpose of our reading:

1. We *read intensively* every word when our purpose demands it.
2. We *skim* if we only wish to quickly get some idea of the material.
3. We *read to orient ourselves* if we want to know where some particular information is to be found in a text.
4. We *read to inform ourselves* when we need certain limited information.

In each of these cases, we leave out anything that does not satisfy the purpose of our reading directly. Different reading objectives (Gunnarsson) or purposes (Möijer) attached to reading give rise to different reading purposes. These purposes differ in terms of the level of text on which the reader focuses, and in terms of how the material is processed. An active reader is skilled in *skimming* the text. Skimming enables the reader to pick out key words and main ideas in the text and, thereby, obtain a great deal of information. Some texts contain so little new information that skimming is all that is required. Before reading a chapter in a textbook, it is helpful to skim the material to identify key topics and to gain a general idea of the structure of the chapter. Difficult material, however, cannot be fully comprehended by skimming or by speed reading (Atkinson et al. 1990).

Gunnarsson (1982) discusses specific reader characteristics from the perspective of the “schemata theory”, which is based on the premise that we store our impressions of our surroundings in the form of schemata. The theory postulates that we have different *partial impressions*, such as, general knowledge about different types of text, and different *whole impressions* of reality. Our deeper understanding of a text is influenced by the schemata that we bring to the fore when we read.

The reading *procedure* is of great importance to the reader’s capacity for understanding a text (Gunnarsson 1982). 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 continuous 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. *Text comprehension* is a constructive process, in which the readers build their perception of the whole by integrating the text with their own experiences and memories.

We learn to sequence information, and as a consequence, to think in linear, sequential ways. In accordance with Perfetti (1977) and Sinatra (1986), understanding of text means a sequential, slow processing to compose and comprehend the contents (“left brain activity”). Retrieval from *verbal memory* is a serial integration and sequential processing of auditory-motor perception systems (Sinatra 1986).

One of the best-known techniques for improving memory from reading is called the PQRS method (Preview, Question, Read, Self-Recitation, and Test). The method is intended to improve students' abilities to study and remember material presented in textbooks. In the first step, the reader previews the chapter at hand to get an idea of its topics and sections, reading the chapter outlines, the section headings, and the summary. The second, third, and fourth stages apply to each section. Trying to answer questions like what?, who?, when?, where?, how?, and why? improve our learning. An active reader adds structure to the text and summarizes the text with keywords. The fifth step, the test, takes place after finishing the work with the chapter. The PQRS method relies on three basic principles for improving memory: (1) organizing the material, (2) elaborating the material, and (3) practising retrieval.

We best remember what we read at the beginning and at the end of a reading session. The optimum time for learning from reading seems to be 20–40 minutes (Atkinson et al. 1990), then it is time for a pause. We will forget most of what we learn if we do not rehearse the material. After finishing reading, it is time for the first rehearsal, reading keywords and notes. It is a good idea to repeat this after a day, after a week, and after a month. Klare (1985: 15) concluded that readers tend to recall better when writers present information:

1. In cause–effect and contrast arrangements rather than in list arrangements.
2. As straightforward (i.e. explicit) relationships rather than those requiring inferences (i.e., implicit).
3. In parallel constructions (i.e., with parts of a sentence parallel in meaning also parallel in structure), rather than in non-parallel constructions.
4. With repeated words and ideas, rather than words which occur only once and ideas which are novel.
5. Tied to a reader's prior knowledge, rather than not tied to a reader's prior knowledge.
6. In main ideas, rather than in details

Learning from reading text is affected in the same way as comprehension. What can be recalled is typically related to how well it was understood 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.

5.4.1.2 *Listening*

Speech does not come to us as a series of individual words. Hearing a sentence, a word, or even a syllable requires the listener to integrate a changing pattern of auditory stimulation. This integration demands some form of short, temporary buffer storage, and it is likely that perception relies heavily on such temporary sensory memory stores that holds a representation of the initial sounds until the entire word has been heard. Thus we must extract the words from a stream of speech. The recognition of words in continuous speech is a complex process. Phonemes are recognized even though their pronunciation is affected by neighbouring sounds and by individual accents. Carlson (1993) noted that our recognition of words in continuous speech is far superior to our ability to recognize them when they have been isolated. We use contextual information in recognizing what we hear.

Cotton (1995b) defined four major levels of listening skills when a teacher is talking or instructing. These levels are (1) skim listening, (2) surveying listening, (3) search listening, and (4) study listening. Most people listen only intermittently and select only things of personal interest. When we study, we take an active part in the content of the material. We read texts, we listen to music, we read pictures. This consciously perceived information is processed, sorted, and stored in certain parts of our long-term memory. In the case of a picture, we may need to focus on different portions of it a number of times (so-called “eye fixations”) to be able to describe it later on.

Pressley and Miller (1987) reviewed experiments concerning children’s listening comprehension and oral prose memory, and concluded that the use of pictures improved learning of prose. They wrote their review as a reflection of Paivio’s dual-coding approach to memory (Paivio 1971, 1983, 1986, 1991). Memory is greater when a verbal and a visual code are activated at the same time, rather than only one of them. After reviewing picture effects on children’s learning Pressley (1977) concluded that enough research evidence already had been gathered regarding illustrated text. Pressley wrote (p. 613): “No more experiments are required to substantiate the positive effect of pictures on children’s learning.”

5.4.1.3 *Pre-understanding*

Both the reading and the listening processes require *decoding* of symbols, *pre-understanding* of words, phrases, pictures, and, finally, *comprehension* of the content of the information. Furthermore, in my view, the legibility, readability, and reading value of the written message influence the reading process. In the case of the spoken message, the message’s audibility, distinctness, and listening value influence the hearing process.

An important step in the reading process is pre-understanding. The graphical form of a text creates expectations in the reader regarding its content. We often

expect certain types of learning material to look in a particular way; contrarily, when we see a document of a certain type we may expect a particular type of text and pictures to accompany it. Thus, it is in the light of these expectations that we activate the cognitive processes needed to interpret the message. The readers develop their own methods for predicting what a text will be about. Introductions, abstracts, tables of contents, summaries, illustrations, and tables all have important functions to fill. To achieve harmony and avoid conflicting interpretations and confusion it is important that the verbal and the visual parts of a message are created in corresponding styles and kinds of content. We usually see the pictures before we read the text (Lidman & Lund 1972). A heading to a text gives the reader a pre-understanding of the contents of that specific text. In many situations pictures may function like headings to the text. We also know that images are interpreted in different ways depending on different assignments (Pettersson 1989).

An immediate image interpretation is handled on a low cognitive level. An analytic image interpretation needs high cognitive level activities. When we see pictures on a printed page we form a mental pre-understanding of the style and the kind of text as well as a pre-understanding of the complete message. We may decide not to read the text at all and leave the page. If we decide to read the text then reading the text and reading the picture makes it possible to create an understanding of the verbo-visual message contents.

Television producers are often good at showing what their programmes are about. In countries with many television channels, it has been noted that viewers switch rapidly between the channels until they find a programme that awakes their interest. Sometimes, a viewer will make up his mind within a couple of seconds (Matsushita 1988). A language that is rich in similes and metaphors makes it easy for the readers to create their inner images. A well constructed text with clear, distinct arrangement and lucid paragraph disposition, organized under well-formulated headings and captions affords the best reading experience.

5.4.2 Learning from visuals

Everyone learns to read words, but we must learn to “read pictures” as well. Therefore, pictorial “language” must be adapted to the viewer’s capacity for interpreting it. Communication can be said to function successfully between the picture maker and the viewer, if the viewer understands, to the fullest extent, what the picture maker wants the picture to say, and if the message conveyed is unambiguous.

It takes a long time to convey a verbal message. Non-verbal information, however, seems to be processed very fast. It only took a few seconds for adult subjects to recognize “two birds” when shown a picture of two flying House Martins (Pettersson 1989, 1993). Processing of visual information starts with attention and percep-

tion. Learning from images is different from learning from text (Sinatra 1986). In order to comprehend visuals, we must be able to process images simultaneously; we must process them in a parallel fashion. We have to learn to read and comprehend the contents of an image. In accordance with Salomon (1979), the process of extracting information from messages that are presented in any symbolic format involves mental activities. In order to make a match between the symbols and their referents in the learner's cognitive schemata, translation or transforming activities are needed. Such processes differ as a function of the symbolic systems used to convey the message. In accordance with Gazzaniga (1967) and Sperry (1973, 1982), perception of two- or three-dimensional representations means parallel, simultaneous, holistic, and fast processing ("right brain activity"). Lodding (1983) concluded that the image memory and processing capabilities of the human mind are extremely powerful.

Equivalence in verbal and visual information was found significantly superior to verbal or visual dominance in its effect on spontaneous recall. Presentations characterized by visual dominance or equivalence in verbal and visual information were found significantly more comprehensible than presentations characterized by verbal dominance. Visual dominance was revealed to have the highest positive effect on generalizations, followed by equivalence, whereas verbal dominance presentations achieved the lowest generalisation scores. The effect of channel dominance on inferential activity interacted with the viewing condition: when viewers were exposed to the visual channel only, visual dominance elicited a higher degree of inferential activity than the presentations characterized by verbal dominance or equivalence.

Although approximately one-third to one-half of the space in science textbooks is devoted to illustrations, most textbook illustrations do not appear to serve any important instructional function (Levin & Mayer 1993; Mayer 1993; Woodward 1993). Research on texts, their language, style, meaning, and social meaning has been going on for a long time. In contrast to extensive research on text processing and text design, there has been less research on the potential power of illustrations for fostering learning from textbooks (Houghton & Willows 1987; Mandl & Levin 1989; Mayer 1989; Willows & Houghton 1987). Evans, Watson and Willows (1987) investigated 11,236 pages in Canadian textbooks. In the textbooks for the junior level of the compulsory school the pictures covered 60–80% of the pages. The figure was 50–70% in textbooks for the intermediate level, and 30–60% in textbooks for the junior high school. In many books for the junior and the intermediate level the pictures occupies such a large space that there is little or no space left for the text. The lack of space combined with the unwillingness to delete information might be one reason for compressed and hard-to-read textbooks.

Evans, Watson and Willows calculated a *frequency index*, the percentage of pages with pictures. The frequency index was 90–100% in textbooks for the junior level, 50–70% in textbooks for the intermediate level, and 30–60% in textbooks for the junior high level. Comparisons between old and modern textbooks often show that both the number of pictures, and the space for pictures have increased. Correspondingly the space for text has decreased. Narrative texts have disappeared for the benefit of short, abstract, descriptive, and fragmentary segments of texts. During the years textbooks have more and more illustrations, and a new kind of layout. Berglund (1991) verified that for each generation the pictures of the textbooks have become more in number, larger, more elegant, and more colourful. An important reason for this is the need for the publishers to be sales oriented. Many colour pictures are used as a competitive means in the continues battle for more customers.

Modern textbooks often have a rich and varied graphic idiom. They include different types of pictures such as colour photos, black and white photos, realistic drawings, diagrams, graphs, maps, collages, cartoons and caricatures. A poll of teachers in Stockholm showed that they often consider the pictures in textbooks as “good”, but that many pictures quite simply are “unnecessary” (Lingons 1987). Less than half of the colour photos (43%), and drawn illustrations (43%) in the textbooks are interpreted as relevant to the texts. At the same time we know that colour pictures are very expensive to buy and to print, and they force up the price of textbooks. Often colour adds no pedagogical value to a picture.

Lindell (1990) summarized an extensive research on the public school system in Sweden, and also on the use of teaching aids. At several inquiries researchers asked pupils and teachers about “the pleasure of working with teaching aids”. A “weighed mean value” for almost 12,000 pupils from 13 inquiries was 3.5 on a scale of one to five. The mean value for 567 teachers in ten inquiries was 3.2. Thus, pupils as well as teachers were satisfied working with the teaching aids available in the schools. However, neither pupils nor teachers are very fond of working with all the pictures in the textbooks.

Levin and Mayer (1993), Mayer (1993), and Woodward (1993) all noted that although approximately one-third to one-half of the space in science textbooks is devoted to illustrations, most textbook illustrations do not appear to serve any important instructional function. In an extensive paper Sims-Knight (1992) reviewed 88 sources on the use of pictures in textbooks. She found that visuals can be effective in their educational function, even if they are unappealing or dull, as long as there is appropriate subject matter content. 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. Taylor (1979) found traditional sex-typing in teaching aids in England, Hilmo (1983) in Norway, Watford

(1983) in the Soviet Union, and Beckius (1987), as well as Benckert and Staberg (1988) in Sweden. Benckert and Staberg concluded that text as well as pictures in a subtle way convey the message that girls are not fit for studying scientific and technical subjects.

A huge body of experiments on learning from visual media exist. However, many of these experiments suffer from severe weaknesses in the experimental designs, in the selection of materials, or in the selection of subjects and their treatment. The main exception from this is the “Program of Systematic Evaluation”, PSE. The PSE was initiated in 1965 by Francis Dwyer at Penn State University in the USA. Dwyer wanted to identify visual materials that are effective in facilitating student achievement of different educational objectives. More than 50,000 high school, college, and adult learners have participated in more than 200 visual research studies.

Results from these studies have been reported by Dwyer several times (1972, 1978, 1982–1983, 1985, and 1994). Throughout the studies, continuity was maintained by utilizing the same 2,000 word instructional unit on the human heart. Visuals range from simple line drawings to realistic photographs, in black and white as well as in colour. A variety of presentation formats, such as booklets, television, and slide-audiotape presentations have been used. The heart content was selected because of its motivational value, and it permitted evaluation of different types of educational objectives. Test formats exist in both verbal and visual versions. According to Dwyer (1985) the effectiveness of a *visual learning environment* is primarily dependent on the following factors:

- The amount of realistic detail in the visual.
- The method for presentation of the visual.
- Student characteristics, such as intelligence and prior knowledge of the subject matter.
- Educational objectives.
- The technique used to focus student attention on the essential learning characteristics.

Eventually, the PSE will develop prescriptive guidelines for the production of effective visual learning materials.

It may be concluded that pictures reinforce our knowledge when they are as close as possible to the real experience. The content, the structure, the context, and the format of a visual influence the viewer’s ability to perceive its message. Bertoline, Burton, and Wiley (1992) discussed three primary stages of *visual learning*. These steps are: (1) visual cognition, (2) visual production, and (3) visual resolve. *Visual cognition* includes: (1) visual perception, the ability to mentally comprehend visual information; (2) visual memory, the ability to mentally store and re-

trieve visual information; and (3) visualization, the ability to mentally create and edit visual information. *Visual production* includes (1) externalisation, the ability to create and edit visual products throughout a design process; (2) transmission, the ability to communicate information through visual products; and (3) reception, the ability to comprehend responses to visual products. *Visual resolve* includes the ability to comprehend the termination of a design process.

Cohen, Ebeling, and Kulik (1981) made a meta-analysis of 74 studies which compared visual-based instruction with conventional instruction. They found that students learned slightly more from visual-based instruction than from traditional teaching, but there was typically no difference between the two groups in regard to course completion, student attitudes, or the correlation between attitudes and achievement. Visuals are very useful in learning tasks that involve memory. The information received from visuals appears to remain longer in memory than information received from verbal information.

Bagget (1989) stated that information obtained visually is more memorable and “bushier” and Kozma (1991) contended that visual symbol systems are better than verbal symbol systems. Nickerson (1965), Shepard (1967), Standing, Conezio, and Haber (1970), and Paivio (1971), have shown that subjects are capable of accurately identifying previously seen pictures. Haber (1979) felt that our ability to recognize pictures can be described as virtually “perfect”. Over a five-day period, Standing (1973) showed subjects 10,000 slides and found that they were able to recognize 83% on a later occasion.

According to Potter and Levy (1969), a person only needed to look at a picture for 1–2 seconds in order to be able to recognize it among other pictures viewed on a subsequent occasion. A child’s inability to assign a name to a previously seen picture could be due to the fact that the picture contents were unfamiliar or because the subject’s distinguishing features were depicted with insufficient clarity. A child may thus recognize a picture subject but have no idea what to call it. Loftus (1972) felt that the number of fixations are decisive to our ability to recall a picture. He found that pictures studied by subjects several times were better remembered than pictures studied less often. Brighthouse (1939), Haber and Erdelyi (1967), and Haber (1979) studied how much subjects actually remembered of picture contents. They found that much more time was needed for people to remember pictures than to merely recognize that they had seen them before. Christianson (1990) showed subjects a series of pictures with emotionally charged, neutral, and unusual contents. The experiments disclosed that the subjects concentrated their attention on the central aspect of a depicted event, that is, the thing that surprised them when they viewed an emotionally charged or unusual event.

5.4.3 Learning from text and visuals

Jonassen, Campbell, and Davidson (1994) remarked that it would be impossible to imagine an information processing system that would be capable of decoding, and, even less possible be capable of recognising, a visual stimulus using only the auditory sensory registers. Several researchers have noted that the human processing system is a multi-dimensional system that is capable of processing and using different types of information through specialized processes (Atkinson & Shiffrin 1968; Baddeley & Hitch 1974; Baddeley & Lieberman 1980 and others).

Wandersee (1992) wanted to know if biology textbooks can be improved so that students are more successful integrating words and images. He used a traditional and a simulated textbook page with information about the prokaryote-eukaryote distinction. The study showed that learners are significantly more successful at identifying unknown cells on unfamiliar micrographs than if they learn from traditional text with a captioned pair of prototype cell micrographs. It appears to be more effective to present examples before nonexamples (e.g., nucleated cells before unnucleated cells), a subtle application of the little-known psychological principle that it is always easier to visually detect the presence of a feature than the absence of it.

Providing illustrations with text is known to usually facilitate learning. Clearly labeled line drawings that isolate important information seem to be the most useful type of illustration (Dwyer, Dwyer, & Canelos 1988). Such visuals help learners to isolate and identify important material, recall prior knowledge, provide interaction with content, and enhance information acquisition. The visuals make the abstract more concrete. Pictures can significantly increase comprehension, recall, and problem solving when they are combined with educational texts. This picture facilitating effect depends on the type of the text, the subjects, the testing methods, the type of pictures, and the role of the pictures in the text (de Lang, 1999). Levin et al. (1987) also concluded that when illustrations are not relevant to the prose contents, no prose-learning facilitation is to be expected. On the contrary, there can be a *negative effect* on understanding and learning. Thus illustrations should not be used only for decoration in information and learning materials.

Many people have experienced how looking at old photographs in a forgotten album can result in a sudden and more or less dramatic flow of various memories. As previously noted Paivio (1983) showed that our memory for pictures is superior to our memory for words. This is called the "*pictorial superiority effect*". It is also known that our memory for a picture-word combination is superior to our memory for words alone, or to our memory for pictures alone (Haber & Myers 1982).

Barry (1998) noted that in tobacco advertising in general, the mandatory cigarette warning label is invariably placed outside of the visual scene, a "tack-on"

of verbiage in an otherwise complete visual story. Visual design elements invariably draw the eye away from the words. The very fact that the format of the warning is verbal assures that it will be processed differently. Words are not only processed differently by the brain, but their nature is more experientially remote and less involving, particularly for children and adolescents. Pezdek and Stevens (1984) found that when children had to choose which of two incompatible channels to process, they preferred the video channel. The auditory information sustains attention and facilitates comprehension. Pezdek and Hartmann (1983) found that video without sound reduced comprehension among preschool children. Rolandelli et al. (1985) concluded that children used the auditory component of television to direct attention to important visual information, as well as to process auditory, especially verbal, content.

Pictures should be put as close to the relevant text as possible (Lidman & Lund 1972; MacDonald-Ross 1977; Hartley & Burnhill 1977; Haber & Hershenson 1980; Wright 1982, Braden 1983; Benson 1985; Pettersson 1989). Design of learning materials should be co-ordinated with a theory of meaningful learning (Fleming & Levie 1993; Mayer 1993). Mayer et al. (1995) built such a theory from components of Wittrock's (1974, 1989) generative learning theory and Paivio's dual coding theory (Paivio 1986; Clark & Paivio 1991).

In this "generative theory of textbook design" Mayer et al. (op. cit.) viewed learning as a constructive process in which learners select and build cognitive connections from among pieces of knowledge. The first constructive processes involve attending to visual and verbal information. Information is moved from sensory memory to short-term memory. The learner must select relevant information from the presented words and build a verbal representation or a "text base". Similarly the learner selects relevant information from the illustrations and builds a visual representation, an "image base". In the next step the learner must reorganize the text base into a verbal mental model of the situation described in the text. The final step is to build one-to-one correspondence between the visual and verbal representations.

Mayer et al. (1995) proposed that learners are most able to build these connections between verbal and visual representations when the corresponding text and illustrations are actively held in memory at the same time. This can happen when text and illustrations are presented in close connection on the same page, or when learners have sufficient experience to generate their own mental images as they read the text. As predicted students who received illustrations integrated with text produced more solutions for problem-solving questions than students who received illustrations separated from the text. The "integrated group" generated approximately 50% more creative solutions on transfer problems than a "separated group", using separated text and illustrations.

Conveying redundant information through both linguistic and iconic symbols facilitates information processing, reduces error and information loss, and increases the amount of information that learners can recall. Linguistic and iconic symbols make it possible for the learners to alternate between functionally independent, though interconnected, and complementary cognitive processing systems.

Mullet and Sano (1995) concluded that (p. 71): “The dominant position of imagery in human communication confers both the greatest opportunity for success and with the greatest risk of failure.” However, when handled correctly the effective use of imagery can make an information and learning material more engaging and enjoyable, which will improve the possibilities for understanding and learning.

5.5 Application of knowledge

After attention, perception, and processing of the information we apply our new knowledge and test it in different applications for confirmation. It is important to *use* new knowledge. We will remember relevant and meaningful information if we have use for it. The usefulness of conclusions made by other people is limited. We must gain confirmation through our own experiences. The information must be internalized and *made our property*, as part of our memory.

New impressions are dependent on and interpreted against a background of our previous experience and learning, our attitudes and interests, our needs and feelings, and the prevailing situation. We direct our attention to things that are large, have a bright colour, move, deviate from the surroundings or familiar patterns, things that arouse feelings and needs, and things which we happen to be interested in at the moment. Memory and experience are successively developed and act as a “cement” in learning. Our previous memory will influence our new learning. This is often very good. Learning in a familiar area is easier, more effective, and more rapid than learning in any new areas. Good experience of previous successful learning is a very good prerequisite for learning of new material. On the other hand, previous “bad experiences” and failures will often have a negative effect on learning in the same area.

Attention makes us receptive to specific data and information in our environment (external context). We select and perceive information that we process into knowledge with reference to our earlier experiences and memories internal context). We apply and test for confirmation. Hereby, knowledge is internalized and influences new attention. Different learning processes are active at the same time. Information is processed into knowledge with continuous parallel and spontaneous learning.

The learning processes do not always start as a direct result of external impulses or “outside” information. Sometimes, an association initiates a conscious process of thought. We may create new knowledge from the experiences and knowledge that we already have. These processes often take place at a subconscious level, and then we are not aware of the processes. That is why we suddenly can get good ideas and solutions to problems that we have had for a long time. It can be concluded that we need to apply and use what we learn. We will remember relevant and meaningful information. Knowledge is internalized, and made our property as part of our memory.

5.5.1 Cognitive style

People are different in many aspects, also when it comes to cognitive aspects and ways of learning. It is possible to distinguish between different cognitive styles and learning styles.

The relationship between the two terms, cognitive style and learning style, has found different viewpoints in the literature. The term cognitive style has often been used interchangeably with learning style. However, Claxton and Ralston (1978) argued that cognitive style was only a type of learning style. Keefe (1979, 1982) extended this view of cognitive style as a sub-category of learning style. In accordance with Keefe, learning styles are cognitive, affective, and physiological traits that serve as relatively stable indicators of how learners perceive, interact with, and respond to the learning environment. In accordance with Messick (1970), “cognitive style” describes the learner’s typical modes of perceiving, thinking, problem solving, and remembering of information. Messick also indicated that each cognitive style has distinct abilities. Each individual has preferred ways of organizing all that he or she sees, remembers, and thinks about. It is possible to organize these styles dimensions in a general way as they concern either reception, concept formation, or retention.

One dimension of the concept cognitive style is “field independence” and “field dependence” (Witkin et al. 1962; Messick 1970; Witkin et al. 1971). Field-independent persons tend to perceive things clearly from the surrounding background and to be highly analytical and systematic, which may be important when interpreting image contents. Field-dependent persons tend to be influenced by background, and perceive the stimulus of the field in which it is embedded as global. Field-independent persons tend to use internal sources of information in perception and problem solving, and to differentiate among experiences. Field-dependent persons tend to refer to external sources of information and to see experiences as integrated.

Moore and Moore (1984) suggest that repetitive subliminal television captions that supplement visible captions may be an effective device for reducing differences in achievement attributable to cognitive style in learning from television programmes. Beaver (1994) noted that we do not learn anything about things that are of no use or no interest for us or that we dislike. In general, field-independent learners are inclined to reorganize or restructure information to suit their specific learning needs; whereas, field-dependent learners are global in that they depend on the external cues, and available structure in the stimulus field (Witkin et al. 1977). The level of field independence for subjects can be determined by their relative performances on the Group Embedded Figures Test (GEFT), as defined by Jackson, Messick, and Myers (1964). Numerous studies show that field independents and field dependents do learn differently, and that field independence/field dependence is an important instructional variable (Dwyer & Moore 1994). In accordance with Dwyer (1994), learners possessing different levels of field-dependence or independence learn quantitatively different amounts from visuals that vary significantly in terms of visual complexity.

5.5.2 Learning styles

Numerous scientists, such as Jung (1964, 1965, 1971), Gardner (1983), Geering (1988), and Hansson (1988) have discussed “learning styles”. A learning style refers to preferences concerning our environment, like sound, light, temperature, moisture, and design of the room, our emotions, and our sociological, physiological, and psychological situation.

Kolb (1984) defined a learning style as a marked preference for one of the modes on each axis in his learning theory model. Thus Kolb gets four learning styles:

1. Accommodators—active and concrete—problem solvers
2. Divergers—reflective and concrete—imaginative and creative
3. Assimilators—abstract and reflective—thoughtful and theoretical
4. Convergers—action-oriented and theoretical

Honey and Mumford (1986) developed a questionnaire with 80 items based on Kolb's learning model. In this model the four learning styles are called: (1) Activist, (2) Reflector, (3) Theorist, and (4) Pragmatist. An activist is a person who prefers the concrete experience mode. Activists involve themselves fully and without bias in new experiences. They enjoy the here and now and are open-minded. Activists tackle problems by brainstorming. A reflector is a person who favours the reflective observation mode. Reflectors like to stand back to ponder experiences and observe them from many different perspectives. They collect data and prefer

to think about it thoroughly before coming to any conclusion. Reflectors like to consider all possible angles and implications before making a decision. A theorist is a person who prefers the abstract conceptualization mode. Theorists adapt and integrate observations into complex but logically sound theories. They think problems through step by step. Theorists are keen on basic assumptions, principles, theories models, and systems thinking. A pragmatist is a person who favours the active experimentation mode. Pragmatists are keen on trying out ideas, theories and techniques to see if they work in practice. They like to get on with things. Pragmatists are practical people. It is noted that every person has a part from each of these four learning styles. Hansson (1988) identified four basic learning styles:

1. Sensing–thinking learner
2. Sensing–feeling learner
3. Intuitive–thinking learner
4. Intuitive–feeling learner

The sensing–thinking learner prefers instruction that focuses on facts and especially on the physical manipulation of tangible objects. He or she likes to know exactly what is expected in each situation. The sensing–feeling learner prefers instruction that focuses on personal values and support for one another. The intuitive–thinking learner prefers instruction that focuses on the meanings and relationships of data. The learner likes problems that require logical analysis and reasoning. The intuitive–feeling learner prefers instruction that allows for personal exploration of a subject or content of personal interest.

Geering (1988) discussed eight learning styles. Extroverted thinkers (1) abound in management, military strategy, and some forms of science. Introverted thinkers (2) are often interested in ideas for their own sake. Extroverted feeling types (3) are deeply interested in other people. Introverted feeling people (4), including those who agonize over the world's problems but internalize them and assume them as a burden. Extroverted sensation types (5), are sports-loving, thrill-seeking, and pleasure-seeking people. Introverted sensation types (6) find the outer world uninteresting and unsatisfying and they turn inwardly to seek fulfilment. Extroverted intuitive people (7) enter new relationships with great gusto but do not always prove dependable. They can move quickly from one new interest to another, especially if it is not immediately fruitful. They have visions of new worlds to conquer or to build. The introverted intuitive people (8) include visionaries and dreamers, who draw from their own hidden resources.

5.5.3 Modalities

People may have visual, auditory, kinesthetic, or tactile modality, or a combination of these. Some people have a mixed modality. In the USA, it has been found that 30% of elementary school children have visual modality, 25% have auditory modality, and 15% have kinesthetic modality. The remaining 30% have a mixed modality (Duffy 1983).

Children with *visual modality* rely very much on seeing things and on their internal visualisation. They learn by seeing; they are “visual learners”. Thus, these children remember faces rather than names. They must take notes and write down verbal information if they need to remember it. Visual modality children are very quiet. They cannot listen for a long period at a time. Visual learners have vivid imagination. They think in images and visualize in components and details rather than the whole. Visual learners are not particularly responsive to music.

Children with *auditory modality* rely very much on hearing and verbalisation. They learn by hearing; they are “auditory learners”. Thus, these children remember names rather than faces. They learn from verbal directions and descriptions. They think in sounds. Auditory modality children talk a lot. They like to hear their own voices. Auditory learners miss significant details in pictures. However, they may appreciate a work of art as a whole. They favour music.

Children with *kinesthetic or tactile modality, or both*, rely very much on their movements and muscular involvement. They learn by doing, and remember what was done rather than seen or heard. Imagery is not important, nor pictures. Kinesthetically-oriented children prefer sculptures that they can touch. When communicating, these children use many bodily expressions. They respond to music by physical movements. Children with *mixed modality* strength learn from visual, auditory, as well as kinesthetic and tactile stimuli.

In accordance with Bagget (1989), elements coming from different modalities can become parts of the same concept. For example, the name of an object, what it looks like, and the actions one performs on it can be included in a single concept. In a dual-media presentation, visuals should be synchronous with verbal information, or precede the verbal information by up to seven seconds. Bagget found that college students comprehend information in a film just as well when visual and verbal elements are presented simultaneously as when they are presented sequentially, doubling study time.

References

- Adams, A. (1999). *Usability testing in information design*. In H. J. G. Zwaga, T. Boersma, & H. C. M. Hoonhout (Eds.). *Visual information for everyday use. Design and research perspectives*. Taylor & Francis: London, Philadelphia.
- Adams, J., & Chambers, R. (1962). Response to simultaneous stimulus of two sense modalities. *Journal of Experimental Psychology*, 63, 125–198.
- AECT Task Force (1977). *Educational technology: Definition and glossary of terms*. Washington, DC: Association for Educational Communications and Technology.
- ALA, American Library Association. (1989). *ALA Presidential Committee on Information Literacy Final Report*. Chicago: ALA, 1989, 7.
- Allmendinger, L. (1998). *Diagrammatic Literacy*. Presentation at Vision Plus 5. Learning meets Information Design, Information Design meets Learning. International Institute for Information Design, Fachhochschul-Studiengänge-Vorarlberg, Austrian Federal Ministry of Science and Transportation, Ministry of Education and Art, UNESCO. Schwarzenberg, Vorarlberg, Austria, July 2–4, 1998.
- American Psychological Association (1996). *Publication Manual of the American Psychological Association. Fourth Edition*. Washington DC: American Psychological Association.
- Anderson, J. R. (1978). Arguments concerning representations for mental imagery. *Psychological Review*, 85, 249–277.
- Anderson, J. R. (1983). *The Architecture of Cognition*. Cambridge: Harvard University Press.
- Arnheim, R. (1969). *Art and Visual Perception*. Berkeley: University of California Press.
- Arnheim, R. (1974). *Art and Visual Perception: A Psychology of the Creative Eye*. Berkeley, CA: University of California Press (rev. ed.).
- Arnheim, R. (1986). *New Essays on the Psychology of Art*. Berkeley: University of California Press.
- Aronsson, K. (1983). *Verklighetens mångtydighet och pekbokens begränsningar. Om bild och begrepp i språkläromedel*. In L. Gustavsson & H. Hult. (Eds.). *Text och bild i läromedel*, SIC 4, 7–24. Linköping: Universitetet i Linköping. Tema Kommunikation.
- Arvidson, P. (1977). *Trovärdighet hos massmedier. En granskning av trovärdighetsforskningens begrepp och metoder*. Psykologiskt försvar. Nr 81. Stockholm: Beredskapsnämnden för psykologiskt försvar.
- Arvidson, P. (1980). *Trovärdighet och förtroende, tillförlitlighet och tillit*. Stockholm: Beredskapsnämnden för psykologiskt försvar.
- Arvidson, P. (1981a). *Tror vi på våra massmedier?* Psykologiskt försvar. Nr 109. Stockholm: Beredskapsnämnden för psykologiskt försvar.
- Arvidson, P. (1981b). *Massmediernas trovärdighet. Sammanfattning av en doktorsavhandling*. Universitetet i Lund.
- Atkinson, R., Atkinson, R. C., Smith, E. E., Bem, D. J., & Hilgard, E. R. (1990). *Introduction to Psychology*. Harcourt Brace Jovanovic Inc.

- Atkinson, R. C., & Shiffrin, R. M. (1968). Human memory: A proposed system and its control processes. In K. W. Spence, & J. T. Spence (Eds.), *The psychology of learning and motivation: Advances in research and theory*, Vol. 2. New York: Academic Press.
- ATLC, Association for Teacher-Librarianship in Canada. (1995). *Students' Bill of Information Rights*. <http://www.sbe.saskatoon.sk.ca/~atlc/studrigh.htm>
- Avgerinou, M. (1997). *Testing Visual Literacy: Some progress with research?* Presentation at the 29th Annual Conference of the International Visual Literacy Association. University Park, Pennsylvania, October 18–22.
- Backman, J., Berg, T., & Sigurdson, T. (1988). *Grundskoleelevers produktion och reception av bilder*. Umeå. Umeå universitet. Institutionen för bildlärarutbildning. Rapport nr 7.
- Baddeley, A. D., & Hitch, G. J. (1974). Working memory. In G. H. Bower (Ed.), *The psychology of learning and motivation*, Vol 8. New York: Academic Press.
- Baddeley, A. D., & Lieberman K. (1980). Spatial working memory. In R. Nickerson (Ed.), *Attention and performance VIII*. Hillsdale, NJ: Erlbaum.
- Bagget, P. (1989). Understanding visual and verbal messages. In H. Mandl & J. Levin (Eds.), *Knowledge acquisition from text and pictures*. Elsevier: Amsterdam, The Netherlands.
- Baron, L. J. (1980). Interaction between television and child-related characteristics as demonstrated by eye movement research. *ECTJ*, 28, 4, 267–281.
- Barry, A.-M. (1998). *The Joe Camel Story: Tobacco Industry Manipulation and the Necessity for Visual Intelligence*. Paper presented at Viscom 12, Winter Park, CO, June 26.
- Barthes, R. (1977). The rhetoric of the image. In *Image, Music, Text, Essays*. Translated by S. Heath. London: Fontana.
- Beaver, D. (1994). *Lazy Learning – Making the most of the Brains You were Born With*. Element Books Limited, Shaftesbury, Dorset.
- Becker, L. B., Martino, R. A., & Towers, W. M. (1976). Media advertising credibility. *Journalism Quarterly*, 53, 216–222.
- Beckius, C. (1987). *Granskningsrapport om könsroller i grundskolans läroböcker i engelska, tyska och franska*. Stockholm: SIL, Statens Institut för Läromedelsinformation. Rapport 1987: 2.
- Benckert, S., & Staberg, E. (1988). *Riktat sig läroböckerna i NO-ämnena mer till pojkar än till flickor? Granskning av några läroböcker i naturorienterade ämnen*. Stockholm: Skolöverstyrelsen, R 88:11- Rapporter, planering, uppföljning, utvärdering.
- Benson, P. J. (1985). Writing visually: Design considerations in technical publications. *Technical Communications Journal*. Fourth Quarter, 35–39.
- Berefelt, G. (1976). *AB Se om bildperception*. Lund: Liber läromedel.
- Berglund, L. (1991). *Att tänka på vid läroboksvalet*. In L. Berglund (Ed.). *Lärobok om läroböcker*. Stockholm: Läromedelsförfattarnas Förening.
- Bergquist, L. (1991). Rationellt författarskap. In S. Selander, L. Olsson, R. Pettersson, & E. Romare (Eds.). Specialnummer: läromedel. Ett utbildningsmaterial om pedagogiska texter. *Spov 14/15*, 17–18.
- Bertin, J. (1967). *Sémiologie Graphique*. Paris and the Hague: Mouton and Gauthiers-Villars.
- Bertin, J. (1983). *Semiology of Graphics*. Translated by P. Berg, Madison: University of Wisconsin Press.
- Bertin, J. (1989). *Graphics and Graphic Information Processing*. Translated by P. Berg and P. Scott, Berlin: William de Gruyter and Co.

- Bertoline, G. R., Burton, T. L., & Wiley, S. E. (1992). Technical graphics as a catalyst for developing visual literacy within general education. In J. Clark-Baca, D. G. Beauchamp, & R. A. Braden (Eds.). *Visual Communication: Bridging Across Cultures*. Selected Readings from the 23rd Annual Conference of the International Visual Literacy Association. Blacksburg: Virginia Tech University.
- Bettinghaus, E. P., & Cody, M. J. (1987). *Persuasive Communication*. Fort Worth: Harcourt Brace Jovanovich College Publishers.
- Biederman, I. (1981). On the semantics of a glance at a scene. In M. Kubovy & J. R. Pomerantz (Eds.). *Perceptual Organization*. Hillsdale, NJ: Lawrence Erlbaum Associates.
- Biederman, I. (1995). *Visual Object Recognition*. In S. M. Kosslyn & D. N. Osherson (Eds.). *Visual Cognition, An Invitation to Cognitive Science*, Second Edition. MA: MIT Press.
- Bloom, B. S., Englehart, M. D., Furst, E. J., Hill, W. H., & Krathwohl, D. R. (1956). *A taxonomy of educational objectives. Handbook I: The cognitive domain*. New York: Longmans, Green and Co.
- Bloom, F. E., Lazerson, A., & Hofstadter, L. (1985). *Brain, mind, and behavior*. New York: W. H. Freeman.
- Boeckman, K. (1987). *The sign structure of realistic images*. Paper presented at the IVLA Symposium Verbo-Visual Literacy: Research and Theory. Stockholm, June 10–13.
- Bondebjerg, I. (1994). Narratives of Reality. Documentary Film and Television in a Cognitive and Pragmatic Perspective. *Nordicom Review*, 1, 65–87.
- Bork, A. (1982). *Information Display and Screen Design*. Paper presented at the American Educational Research Association Conference. New York.
- Braden, R. (1983). *Visualizing the verbal and verbalizing the visual*. In R. Braden & A. Walker (Eds.). *Seeing Ourselves, Visualization In a Social Context: Readings From The 14th Annual Conference Of The International Visual Literacy Association*. Blacksburg VA. Virginia Polytechnic Institute and State University.
- Braden, R. (1985). *The stylish look: A format for visual literacy writers*. In N. Thayer & S. Clayton-Randolph (Eds.). *Cruising In The Future: Readings From The 16th Annual Conference Of The International Visual Literacy Association*. Bloomington Indiana: Western Sun Printing Co.
- Bradshaw, A. C. (2000). *Evaluating Visuals for Instruction*. In R. E. Griffin, W. J. Gibbs, & V.S. Villiams (Eds.). *Natural Vistas Visual Literacy & The World Around Us. Selected Readings of the International Visual Literacy Association*. International Visual Literacy Association.
- Branch, R. C., & Bloom, J. R. (1995). *The Role of Graphic Elements in the Accurate Portrayal of Instructional Design*. In D. G. Beauchamp, R. A. Braden, & R. E. Griffin (Eds.). *Imagery and Visual Literacy*. The International Visual Literacy Association.
- Briggs, L. J., & Wager, W. W. (1989). *Handbook of procedures for the design of instruction*. Englewood Cliffs. N.J.(USA): Educational Technology Publications. Brown, L. (Ed.), (1993). *The new Shorter Oxford English Dictionary on Historical Principles*. Oxford: Clarendon Press.
- Brighouse, G. (1939). A study of aesthetic apperception. *Psychological Monographs*, 51, 1–22.
- Brody, P. J. (1982). Affecting instructional textbooks through pictures. In D. H. Jonasson (Ed.). *The Technology of Text*. Englewood Cliffs, NJ: Educational Technology Publications.
- Brown, L. (Ed.). (1993). *The new Shorter Oxford English Dictionary on Historical Principles*. Oxford: Clarendon Press.
- Brown, C. A., & Bookman, M. (1997). *Guide to On-Line Publishing for Reading Comprehension*. Sentius Corporation: Rev. 1/23/97. (Web site www.sentius.com)

- Brun, T. (1974). *The International Dictionary of Sign Language*. Halmstad: Spektra, Swedish translation.
- Bruner, J. (1966). *Toward a Theory of Instruction*. Harward University Press: Cambridge.
- Buckingham, D. (1993). *Children Talking Television: The Making of Television Literacy*. London: The Falmer Press.
- Burns, D., Venit, S., & Hansen, R. (1988). *The electronic publisher*. New York: Brady.
- Carlson, N. R. (1993). *Psychology, The Science of Behavior. Fouth Edition*. Needham Heights, MA: Allyn and Bacon.
- Catalano, K. (1990). On the wire: How six news services are exceeding readability standards. *Journalism Quarterly*, 67, 1, Spring, pp. 97–103.
- Christianson, S.-Å. (1990). Vad minns vi av en fasansfull upplevelse? *Forskning och Framsteg*, 1/90, 14–19.
- Cifuentes, L., Myers, L. J., & McIntosh, K. (1998). Selective Data Analyses, Photo Manipulation, and Honest Message Design. *Journal of Visual Literacy, Autumn 1998, Volume 18, Number 2*, 165–174.
- Cisotto, L., & Boscolo, P. (1995). *Effects of paragraph subtitles and underlining on written summaries*. Presentation at the 6th European Conference for Research on Learning and Instruction. European Association for Research on Learning and Instruction. Nijmegen, August 26–31.
- Clark, R. E. (1984). Research on student thought processes during computer-based instruction. *Journal of Instructional Development*, 7, 3, 2–5.
- Clark, J. M., & Paivio, A. (1991). Dual coding theory and education. *Educational Psychology Review*, 3, 149–210.
- Claxton, C. S., & Ralston, S. (1978). *Learning Styles: Their Impact on teaching and administration*. (AAHE-ERIC/Higher Education Report, 10.) Washington, DC. American Association of Higher Education.
- Clements, E. (1984). *Attention: a theoretical perspective*. In A. D. Walker, R. A. Braden, & L. H. Dunker. *Visual Literacy – Enhancing Human Potential*. Readings from the 15th Annual Conference of thje International Visual literacy Association, Virginia Polytechnic Institute and State University. Blacksburg, VA.
- Cochran, L. M. (1987). Visual/Verbal Languageing as Metaphor. Paper presented at the Symposium on Verbo-Visual Literacy: Research and Theory. Stockholm, June 10–13.
- Cohen, P., Ebeling, B., & Kulik, J. (1981). A meta-analysis of outcome studies of visusal-based instruction. *Educational Communications and Technology Journal*, 29, 26–36.
- Coll, R., Coll, J. H., & Thakur, G. (1994). Graphs and tables: a four factor experiment. *Communications of the ACM*, 37 (4), 77–86.
- Collier, D., & Cotton, B. (1989). *Basic Desktop Design and Layout*. Cincinnati, OH: North Light Books.
- Commission on Instructional Technology. (1970). *To improve learning. A report to the President and theCongress of the United States*. Washington, DC. Commission on Instructional Technology.
- Considine, D. M., & Haley, G. E. (1992). *Visual Messages. Integrating Imagery into Instruction*. Englewood , Colorado. Teacher Ideas Press.
- Cook, T. D., & Flay, B. (1978). *The Temporal Persistence of Experimentally Induced Attitude Change: An Evaluative Review*. In L. Berkowitz (Ed.). (1978) *Advances in Experimental Social Psychology*. New York: Academic.
- Cotton, J. (1995a). *The Theory of Learning. An Introduction*. London: Kogan Page.

- Cotton, J. (1995b). *The Theory of Learners. An Introduction*. London: Kogan Page.
- Dahlstedt, K. H. (1979). *Språk och massmedier*. Presentation at the IVth Nordic Conference for Mass Communication, Umeå University.
- Dake, D. M. (2000). *A natural Visual mind: The Art And Science Of Visual Literacy*. In R. E. Griffin, W. J. Gibbs, & V.S. Villiams (Eds.) 2000: *Natural Vistas Visual Literacy & The World Around Us. Selected Readings of the International Visual Literacy Association*. International Visual Literacy Association.
- Davies, F. E., Barry, J., & Wiesenbergh, M. (1986). *Desktop Publishing*. Homewood, IL: Dow Jones-Irwin.
- Debes, J. L. (1969). The loom of visual literacy. *Audiovisual Instruction*, 14, 25–27.
- deLange, R. W. (1996). *Cultural Modifications in Visuals as a Support to Printed Educational Media in Africa: an Erroneous Paradigm*. Paper presented at The 4th International Research Symposium on Visual Verbal Literacy, Process and Product: Media Education in Praxis, The Rijkshogeschool, IJsselland, and the International Visual Literacy Association, Deventer, Holland, May 6–11, 1996.
- deLange, R. W. (1999). *Increasing The Facilitating Effect Of Pictures In Educational Text*. In R. E. Griffin, W. J. Gibbs, & B. Wiegman (Eds.) 1999: *Visual Literacy In An Information Age*. International Visual Literacy Association.
- De Vaney, A., & Butler, R. P. (1997). *Voices of the Founders: Early Discourses in Educational Technology*. In D. H. Jonassen (Ed.). *Handbook of Research for Educational Communications and Technology*. Simon & Schuster: New York.
- Dijkstra, S., van Hout Wolters, B. H. A. M., & van der Sijde, P. C. (Eds.). (1990). *Research on Instruction Design and Effects*. Englewood Cliffs, NJ: Educational Technology Publications.
- Doblin, J. (1980). A structure for nontextual communications. In P. A. Kolers, M. E. Wrolstad, & H. Bouma (Eds.). *The Processing of Visible Language: Vol. 2*. New York: Plenum Press.
- Dondis, D. A. (1973). *A Primer of Visual Literacy*. Cambridge, MA: Massachusetts Institute of Technology.
- Doyle, C. A. (1994). *Final Report to the National Forum on Information Literacy*. In *From Library Skills to Information Literacy: A Handbook for the 21st Century*. Castle Rock, CO: Hi Willow Research & Publishing. (See http://inet.ed.gov/databases/ERIC_Digests/ed372756.html)
- Dreilinger, S. (1993). *Art and the User Interface*. http://www.kensho.com/pubs/art-and-ui/Art-and-the-User-Interface_ToC.html
- Drew, D. G., & Grimes, T. (1985). *The Effect of Audio-Visual Redundancy on Audio and Video Recall in Television News*. Paper presented at the annual meeting of the Association for Education in Journalism and Mass Communication (68th, Memphis, TN, August).
- Dryden, J., & Vos, J. (1994). *The Learning Revolution*. Auckland, New Zealand: Profile Books.
- Duchastel, P. C. (1978). Illustrating instructional texts. *Educational Technology*, 18, 36–39.
- Duchastel, P. C. (1983). Text Illustrations. *Performance and Instruction*, 22, 3–5.
- Duchastel, P. C., & Brown, B. R. (1974). Incidental and relevant learning with instructional objectives. *Journal of Educational Psychology*, 66, 481–485.
- Duchastel, P. C., & Waller, R. (1979). Pictorial illustration in instructional texts. *Educational Technology*, 19, 20–25.
- Duchnick, R. L., & Kolers, P. A. (1983). Readability of text scrolled on visual display terminals as a function of window size. *Human Factors*, 25, 683–692.
- Duffy, B. (Ed.). (1983). *One of a Kind. A Practical Guide to Learning Styles 7–12*. Oklahoma State Department of Education.

- Dwyer, F. M. (1972). *A Guide for Improving Visualized Instruction*. State College, PA: Learning Services.
- Dwyer, F. M. (1978). *Strategies for Improving Visual Learning*. State College, PA: Learning Services.
- Dwyer, F. M. (1982–1983). The program of systematic evaluation – a brief review. *International Journal of Instructional Media*, 10, 23–39.
- Dwyer, F. M. (1985). Visual literacy's first dimension: Cognitive information acquisition. *Journal of Visual/Verbal Language*, 5, 7–15.
- Dwyer, F. M. (1993). *Visualization & Technology: A Global Perspective*. Paper presented at the 25th Annual Conference of the International Visual Literacy Association. Rochester, Oct. 13–17. 1993.
- Dwyer, F. M. (1994). *One Dimension of Visual Research: A Paradigm and Its Implementation*. In D. M. Moore & F. M. Dwyer (Eds.). *Visual Literacy: A Spectrum of Visual Learning*. Englewood Cliffs, NJ: Educational Technology Publications.
- Dwyer, F. M., Dwyer, C. A., & Canelos, J. C. (1988). *Enhancing visualized instruction*. Paper presented at the Twentieth Annual Conference of the International Visual Literacy Association, Blacksburg, VA, October 19–23.
- Dwyer, F. M., & Moore, D. M. (1994). *Effect of Color Coding and Test Type (Visual/Verbal) on Students Identified as Possessing Different Field Dependent Levels*. Presentation at International Visual Literacy Association Annual Conference, Tempe, AZ, October 15.
- Easterby, R., & Zwaga, H. (Eds.). (1984). *Information Design. The design and evaluation of signs and printed material*. John Wiley and Sons Ltd.
- Eco, U. (1971). *Den frånvarande strukturen. Introduktion till den semiotiska forskningen*. Lund, Swedish translation.
- Edwards, D. C., & Coolkasian, A. (1974). Peripheral vision location and kinds of complex processing. *Journal of Experimental Psychology*, 102, 244–249.
- Ehrenberg, A. S. C. (1977). Rudiments of numeracy. *Journal of the Royal Statistical Society*, 140, 277–297. Cited by E. R. Misanchuk (1992). *Preparing Instructional Text: Document Design Using Desktop Publishing*. Englewood Cliffs, NJ: Educational Technology Publications.
- Ehrenberg-Sundin, B. (1982). Bättre planerade texter sparar miljoner kronor. *Klarspråk från SB, Språkspalter i Klara-Posten*, 1982–1985.
- Ehrenborg, J. (1984). *Muntlig kommunikation*. Göteborg: Svenska ManagementGruppen.
- Eklund, S. (1990). *Bedömning av kunskaper och färdigheter i bild, årskurs 2. Del av en nationell utvärdering av grundskolan*. Umeå. Umeå Universitet. Institutionen för bildlärarutbildning. Rapport nr. 10.
- Ekwall, E. (1977). *Diagnosis and Remediation of the Disabled Reader*. Boston: Allyn and Bacon.
- Elkind, D. (1975). We can teach reading better. *Today's Education*, 64, 34–38.
- Enser, P. G. B. (1995). Progress in documentation. Pictorial information retrieval. *Journal of Documentation*, 51 (2), 126–170.
- Erstad, O. (1998). *Media Literacy among Young People. Integrating Culture, Communication and Cognition*. In B. Höijer & A. Werner (Eds.). *Cultural Cognition. New perspectives in audience theory*. NORDICOM: Göteborg.
- Esdale, B., & Robinson, R. (1982). *Viewing in Secondary Language Arts*. Edmonton, Alberta: Alberta Education.
- Evans, H. (1978). *Editing and Design. Pictures on a Page*. London: Heinemann.

- Evans, M. A., Watson, C., & Willows, D. M. (1987). *A Naturalistic Inquiry into Illustrations in Instructional Textbooks*. In H. A. Houghton and D. M. Willows. (Eds.). *The Psychology of illustrations: Vol 2. Instructional Issues*, 53–85. NY: Springer-Verlag.
- Fast, J. (1971). *Body Language*. Stockholm, Swedish translation.
- Fetveit, A. (1997). *The digitalized screen: revisiting the issue of indexicality*. Paper presented at The 13th Nordic Conference for Research on Mass Communications, August 9.12, Jyväskylä, Finland.
- Findahl, O., & Höijer, B. (1979). *Vad säger oss nyhetsprogrammen? Del 1. Krisen i svensk industri*. Sveriges Radio, PUB, 5.
- Findahl, O., & Höijer, B. (1980). *Vad säger oss nyhetsprogrammen? Del 2. Avtalsrörelsen, kärnkraften, löntagarfonderna*. Sveriges Radio, PUB, 8.
- Findahl, O., & Höijer, B. (1984). *Begriplighetsanalys*. Lund: Studentlitteratur.
- Fleming, M. L. (1969). Eye movement indices of cognitive behavior. *AV Communication Review*, 17, 383–398.
- Fleming, M. L., & Levie, W. H. (1978). *Instructional Message Design*. Englewood Cliffs, NJ: Educational Technology Publications.
- Fleming, M. L., & Levie, W. H. (Eds.). (1993). *Instructional Message Design* (2nd ed.). Englewood Cliffs, NJ: Educational Technology Publications.
- Fransecky, R. B., & Debes, J. L. (1972). *Visual literacy: A way to learn – a way to teach*. Washington, DC: Association for Educational Communications and Technology.
- Frase, L. T., & Schwartz, B. J. (1970). Typographical cues that facilitate comprehension. *Journal of Educational Psychology*, 71, 197–206.
- Fredette, B. W. (1993). *Aesthetics for the 21st century: another challenge for education*. Presentation at the 3rd International Symposium of the International Visual Literacy Association. Verbo-Visual Literacy: Understanding and Application of new Educational Communication Media Technologies. Delphi, Greece, June 26–29, 1993.
- Fredriksson, I. (1979). *Konsten spränger ramarna. John Hartfield och det politiska fotomontaget*. Stockholm: Akademilitteratur.
- Friedman, M. (1989). *Opening a History*. In M. Friedman & P. Freshman (Eds.). *Graphic Design in America: a Visual Language History*. Minneapolis: Walker Art Center, and New York: Harry N. Abrams Inc.
- Gagné, R. W. (1977). *The conditions of learning* (3rd ed.). New York: Holt, Rinehart, and Winston.
- Gagné, R. W. (1985). *The conditions of learning* (4th ed.). New York: Holt, Rinehart, and Winston.
- Gagné, R. W., & Briggs, L. J. (1974). *Principles of Instructional Design*. New York: Holt, Rinehart, & Winston.
- Gagné, R. M., Briggs, L. J., & Wager, W. W. (1988). *Principles of Instructional Design* (Third Edition). New York: Holt, Rinehart, & Winston.
- Gardner, H. (1983). *Frames of Mind: The Theory of Multiple Intelligence*. New York: Basic Books.
- Gazzaniga, M. (1967). The split brain in man. *Scientific American*, 217, 24–29.
- Gazzaniga, M. S., & Le Doux, J. (1978). *The Integrated Mind*. New York: Plenum Press.
- Geering, L. (1988). *In the World Today*. Wellington: Allen & Unwin and Port Nicholson Press.
- Gibson, J. J. (1966). *The Senses Considered as Perceptual Systems*. Boston: Houghton Mifflin.
- Gibson, J. J. (1971). The information available in pictures. *Leonardo*, 4, 27–35.
- Glaser, R. (1978). *The design of instruction*. In J. I. Goodland (Ed.). *The changing american school: NSSE 65th Yearbook*. Chicago: University of Chicago Press.

- Glynn, S. M., Britton, B. K., & Tillman, M. H. (1985). Typographic cues in text: Management of the reader's attention. In D. H. Jonassen (Ed.). *The Technology of Text: Principles for Structuring, Designing, and Displaying Text. Volume 2*. Englewood Cliffs, NJ: Educational Technology Publications.
- Gombrich, E. H. (1969). *Art and Illusion: A Study in the Psychology of Pictorial Representation*. Princeton, NJ: Princeton University Press.
- Goodman, N. (1976). *Languages of Art: An Approach to a Theory of Symbols (2nd ed.)*. Indianapolis, IN: Hackett Publishing.
- Gould, J. (1973). Eye movement during visual search and memory search. *Journal of Experimental Psychology*, 98, 184–195.
- Gray, B. (1989). *Critical TV Viewing Skills: A Paradigm for Program Development*. In R. A. Braden, D. G. Beauchamp, L. V. W. Miller, & D. M. Moore (Eds.). *About Visuals: Research, Teaching and Applications*. Readings From the 20th Annual Conference of the International Visual Literacy Association. Blacksburg: Virginia Tech University, 161–166.
- Gregory, R. L. (1978). *Eye and Brain* (3rd ed.). New York: McGraw-Hill.
- Gregory, M., & Poulton, E. C. (1970). Even versus uneven right-hand margins and the rate of comprehension in reading. *Ergonomics*, 13, 427–434.
- Griffin, R. E. (1989). *A comprehensive study of the types of visuals used in business and engineering presentations*. In R. A. Braden, D. G. Beauchamp, L. V. W. Miller, & D. M. Moore (Eds.). *About Visuals: Research, Teaching, and Applications*. Readings from the 20th Annual Conference of the International Visual Literacy Association. Blacksburg: Virginia Tech University.
- Griffin, R. E. (1990). *Important Facts about Business Presentations*. State College: Penn State University.
- Griffin, R. E., Pettersson, R., Semali, L., & Takakuwa, Y. (1994). *Using Symbols In International Business Presentations: How Well are They Understood?* Paper presented at the 26th Annual Conference of the International Visual Literacy Association. Tempe, Oct. 12–16. Published In D. G. Beauchamp, R. A. Braden, & R. E. Griffin, (Eds.), (1994) *Imagery and Visual Literacy. Selected Readings from the 26th Annual Conference of the International Visual Literacy Association*. International Visual Literacy Association. 1995.
- Guba, W., Wolf, W., deGroot, S., Knemeyer, M., Van Atta, R., & Light, L. (1964). Eye movements and TV viewing in children. *AV Communication Review*, 12, 381–401.
- Gunnarsson, B.-L. (1982). *Lagtexters begriplighet. En språkfunktionell studie av medbestämmandelagen*. Liber Förlag: Stockholm.
- Gunnemark, E., & Kenrick, D. (1985). *A Geolinguistic Handbook*. Kungälv: Goterna.
- Haber, R. N. (1979). How we remember what we see. *Scientific American*, 222, 104–115.
- Haber, R. N., & Erdelyi, M. H. (1967). Emergence and recovery of initially unavailable perceptual material. *Journal of Verbal Learning and Verbal Behavior*, 6, 618–628.
- Haber, R. N., & Haber, L. R. (1981). Visual components of the reading process. *Visual Language*, 15, 149.
- Haber, R. N., & Hershenson, M. (1980). *The Psychology of Visual Perception*. New York: Holt, Rinehart, & Winston.
- Haber, R. N., & Myers, B. L. (1982). Memory for pictograms, pictures, and words separately and all mixed. *Perception*, 11, 57–64.
- Hagen, I. (1998). *Creation of Socio—Cultural Meaning. Media Reception Research and Cognitive Psychology*. In B. Höijer & A. Werner (Eds.). *Cultural Cognition. New perspectives in audience theory*. NORDICOM: Göteborg University.

- Hall, S. (1980). *Encoding/Decoding*. In S. Hall, D. Dobson, A. Lowe, & P. Willis (Eds.). *Culture, Media, Language*. London: Hutchinson.
- Hallberg, Å. (1992). *Typografin och läsprocessen. Grafisk kommunikation med text och bild*. Spektra: Halmstad.
- Hancock, V. (1993). *Information Literacy for Lifelong Learning*. ERIC Digest. ED 358870.
- Hannafin, M. J., & Hughes, C. (1986). A framework for incorporating orienting activities in computer-based interactive video. *Instructional Science*, 15, 239–255.
- Hansen, Y. (1989). *An Adult Handbook to Develop Visual Thinking: How to Use Simple Graphic Tools for Thinking, Planning, and Problem Solving*. In R. A. Braden, D. G. Beauchamp, L. V. W. Miller, & D. M. Moore (Eds.). *About Visuals: Research, Teaching, and Applications*. Readings from the 20th Annual Conference of the International Visual Literacy Association. Blacksburg: Virginia Tech University.
- Hanson, J. R. (1988). Learning styles, visual literacies, and a framework for reading instruction. *Reading Psychology: An International Quarterly*, 9, 409–430.
- Harrison, H. (Ed.). (1981). *Picture Librarianship. (Handbook on Library practice.)* Library Association Publishing: London.
- Hartley, J. (1980). Spatial cues in text: Some comments on the paper by Frase, & Schwartz (1979). *Visible Language*, XIV, 62–79.
- Hartley, J. (1987). Designing electronic text: The role of print-based research. *Educational Communication and Technology Journal*, 35, 3–17.
- Hartley, J., & Burnhill, P. (1977). Fifty guidelines for improving instructional text. *Programmed Learning and Educational Technology*, 14, 65–73.
- Hayward, A. L., & Sparkes, J. J. (1984). *The Concise English Dictionary*. London: Omega Books.
- Head, A. J. (2000). *Design Wise. A guide for evaluating the interface design of information resources*. Medford, New Jersey: Cyber Age Books.
- Heinich, R., Molenda, M., & Russell, J. D. (1982). *Instructional Media and the New Technologies of Instruction*. New York: Macmillan
- Helmholz, H. C. F. (1924). *Physiological Optics. Vol II.* (J. Southall Rochester, Trans.) NY: Optical Society of America.
- Helyar, P. S. (1992). Products Liability: Meeting Legal Standards for Adequate Instructions. *Journal of Technical Writing and Communication*. 22, 2, 125–147.
- Henney, M. (1981). The effect of all-capital print versus regular mixed print as displayed on a micro-computer screen on reading speed and accuracy. *Educational Communications and Technology Journal*, 31, 126.
- Hewson, D. (1988). *Introduction to Desktop Publishing*. San Francisco, CA: Chronicle Books.
- Hightower, C. (1989). *Foreword*. In M. Friedman and P. Freshman (Eds.). *Graphic Design in America: A Visual Language History*. Minneapolis: Walker Art Center, and New York: Harry N. Abrams Inc.
- Hilmo, I. (1983). *An analysis of Norweigian textbooks in science*. Contributions to the second GASAT conference. Oslo.
- Holliday, W. (1980). Using visuals to teach concepts. *Science and Children*, 17, 9–10.
- Honey, P., & Mumford, A. (1986). *The Manual of Learning Styles*. Maidenhead Berkshire: Ardingly House.
- Horn, R. E. (1999). *Information Design: Emergence of a New Profession*. In R. Jacobson (Ed.). *Information Design*. Cambridge, Massachusetts. London, England. Massachusetts Institute of Technology: The MIT Press.

- Horton, W. (1991). *Illustrating Computer Documentation. The Art of Presenting Information Graphically on Paper and Online*. New York: John Wiley & Sons, Inc.
- Houghton, H. A., & Willows, D. M. (Eds.). (1987). *The psychology of illustration: Vol. 2, Instructional issues*. New York: Springer-Verlag.
- Hubel, D. H., & Wiesel, T. N. (1962). Receptive fields, binocular interaction, and functional architecture in the cat's visual cortex. *Journal of Physiology*, 160, 106–154.
- Hugo, J., & Skibbe, A. (1991). Facing visual illiteracy in South African health education: a pilot study. *Journal of Audiovisual Media in Medicine*, 14, 47–50.
- Hunter, B., Crismore, A., & Pearson, P. D. (1987). Visual displays in basal readers and social studies textbooks. In H. A. Houghton, & D. M. Willows (Eds.). *The Psychology of Illustrations: Vol 2. Instructional Issues*. New York: Springer-Verlag.
- Hård, A., & Sivik, L. (1981). NCS–Natural Color System: A Swedish standard for color-notation. *Color Research and Application*, 6, 3, 129–138.
- Höglund, L. (Ed.). (1995). *Biblioteken, kulturen och den sociala intelligensen. Aktuell forskning inom biblioteks- och informationsvetenskap*. Forskningsrådsnämnden, Publiceringsföreningen VALFRID: Göteborg.
- Höijer, B. (1992a). Socio-Cognitive Structures and Television Reception. *Media, Culture and Society*, 14, 583–603.
- Höijer, B. (1992b). Reception of Television Narration as a Socio-cognitive Process: A Schema-Theoretical Outline. *Poetics*, 21, 283–304.
- IDA, The Information Design Association. (1997). *The origins of the IDA*. <http://www.popcomm.co.uk/ida/origins.html>
- IIID, International Institute for Information Design. (1997). *International Institute for Information Design. Definitions*. <http://www.simlinger-iiid.magnet.at/simlinger-iiid/English-2.html>
- Ingvar, D. H., & Hallberg, Å. (1989). *Hjärnan, bokstaven, ordet*. Spektra: Halmstad.
- Isaacs, G. (1987). Text screen design for computer-assisted learning. *British Journal of Educational Technology*, 18, 41–51.
- Jacobson, R. (1976). *Språket i relation till andra kommunikationssystem*. In K. Aspelin, & B. A. Lundberg (Eds.). *Tecken och tydning. Till konsternas semiotik*. Stockholm.
- Jackson, D. N., Messick, S., & Myers, C. T. (1964). Evaluation of group and individual forms of embedded figures measures of field independence. *Educational and Psychological Measurement*, 24 (2), 177–192.
- Jonassen, D. H. (1982). *The Technology of Text, Principles for Structuring, Designing, and Displaying Text. Volume 1*. Englewood Cliffs, NJ: Educational Technology Publications.
- Jonassen, D. H., Campbell, J. P., & Davidson, M. E. (1994). Learning with Media: Restructuring the Debate. *Educational Technology, Research and Development*, 42, 2, 31–39.
- Jonassen, D. H., & Kirschner, P. A. (1982). Introduction to section 2: Explicit techniques for structuring text. In D. H. Jonassen (Ed.). *The Technology of Text: Principles for Structuring, Designing, and Displaying Text. Volume 2*. Englewood Cliffs, NJ: Educational Technology Publications.
- Judson, H. (1972). *The Techniques of Reading* (3rd ed.). New York: Harcourt, Brace, Jovanovich.
- Jung, C. G. (1964). *Man and His Symbols*. New York: Dell.
- Jung, C. G. (1965). *Memories, Dreams, and Reflections*. New York: Vintage Books.
- Jung, C. G. (1971). *Psychological Types*. Princeton, NJ: Princeton University Press.
- Kaniza, G. (1979). *Organization in vision: Essays on gestalt perception*. New York: Praeger.

- Kant, I. (1790/1951). *Critique of judgement*. (J. H. Bernard, Trans.) New York: Hafner. (Original work published 1790.)
- Katz, E., Blumler, J. G., & Gurevitch, M. (1974). *Utilization of mass communication by the individual*. In J. G. Blumler & E. Katz (Eds.). *The Uses of Mass Communications: Current Perspectives on Gratifications Research*. Beverly Hills: Sage.
- Keates, J. S. (1982). *Understanding Maps*. London and New York: Longman.
- Keefe, J. W. (1979). *Learning Styles: an overview*. In *Student Learning Styles: Learning Styles and Brain Behavior*. Reston, VA: NASSP Publications.
- Keefe, J. W. (1982). Assessing student learning styles: An overview. In *Student Learning Styles*. Virginia: NASSP Publications.
- Keller, J., & Burkman, E. (1993). Motivation principles. In M. Fleming & W. H. Levie (Eds.). *Instructional Message Design* (2nd ed.). Englewood Cliffs, NJ: Educational Technology Publications.
- Key, W. B. (1977). *Subliminal Seduction*. New York: Signet.
- Kirkman, J. (1992). *Good style. Writing for science and technology*. EFN Spon: London.
- Kirkman, J. (1993). *Full Marks*. Ramsbury Books.
- Klapp, S. T., & Netick, A. (1988). Multiple resources for processing and storage in short-term working memory. *Human Factors*, 30 (5), 617–632.
- Klare, G. R. (1985). *How to write readable English*. London: Hutchinson.
- Klatzky, R. L. (1980). *Human memory: Structures and processes*. New York: W. H. Freeman.
- Kleper, M. L. (1987). *The Illustrated Handbook of Desktop Publishing and Typesetting*. Blue Ridge Summit, PA: Tab Books.
- Knave, B. (1983). The visual display unit. In *Ergonomic Principles in Office Automation*. Uddevalla: Ericsson Information Systems AB.
- Kolb, D. A. (1984). *Experiential Learning*. Englewood Cliffs, NJ: Prentice Hall.
- Kosbiech, K. (1976). The importance of perceived task and type of presentation in student response to instructional television. *AV Communication Review*, 24, 401–411.
- Kosslyn, S. M. (1975). Information representation in visual images. *Cognitive Psychology*, 7, 341–370.
- Kozma, R. B. (1991). Learning with media. *Review of Educational Research*, 61, 2, 179–212.
- Kulhavy, R. W., Lee, J. B., & Caterino, L. C. (1985). Conjoint retention of maps and related discourse. *Contemporary Educational Psychology*, 10, 28–37.
- Lang, K. (1987). *The Writer's Guide to Desktop Publishing*. London: Academic Press.
- Larsson, L.-O. (1993). *Totalinformation. En modell*. Halmstad: AffärsFörlaget Mediautveckling.
- Lauer, D. A. (1990). *Design Basics*. Florida: Harcourt Brace Jonovich, Inc.
- Lawson, L. (1968). *Ophthalmological factors in learning disabilities*. In H. Myklebust, (Ed.). *Progress in Learning Disabilities*. (Vol. 1.) New York, Grune and Stratton.
- Leahy, S. B. (1991). *Visual literacy: Investigation of visual literacy concepts as historically developed in writings of selected western philosophers from the pre-Socratics to Comenius*. In D. G. Beauchamp, J. Clark-Baca, & R. A. Braden (Eds.). *Investigating Visual Literacy*. Selected Readings from the 22nd Annual Conference of the International Visual Literacy Association. Blacksburg: Virginia Tech University.
- Lenze, J. S. (1991). *Serif vs. san serif type fonts: A comparison based on reader comprehension*. In D. G. Beauchamp, J. Clark Baca, & R. A. Braden (Eds.). *Investigating Visual Literacy, Selected Readings From The 22nd Annual Conference Of The International Visual Literacy Association* 93–97.

- Leshin, C. B., Pollock, J., & Reigeluth, C. M. (1992). *Instructional design strategies and tactics*. Englewood Cliffs, NJ: Educational Technology Publications.
- Lester, P. M. (1995). *Visual Communication. Images with Messages*. Belmont, CA: Wadsworth Publishing Company. A Division of International Thomson Publishing Inc.
- Levie, W. H. (1987). Research on Pictures: A Guide to the Literature. In D. M. Willows & H. A. Houghton (Eds.). *The Psychology of Illustration: Vol. 1. Basic Research*. New York: Springer-Verlag.
- Levie, W. H., & Lentz, R. (1982). Effects of text illustrations: A review of research. *ECTJ*, 30, 4, 195–232.
- Levin, J. R. (1973). Inducing comprehension in poor readers: a test of a recent model. *Journal of Educational Psychology*, 65, 19–24.
- Levin, J. R. (1981). On functions of pictures in prose. In F. J. Pirozzolo & M. C. Wittrock (Eds.). *Neuropsychological and Cognitive Processes in Reading*. New York: Academic Press.
- Levin, J. R., Anglin, G. J., & Carney, R. N. (1987). On empirically validating functions of pictures in prose. In D. M. Willows & H. A. Houghton (Eds.). *The Psychology of Illustration: Vol. 1. Basic Research*. New York: Springer-Verlag.
- Levin, J. R., Divine-Hawkins, P., Kerst, S., & Guttman, J. (1974). Individual differences in learning from pictures and words: The development and application of an instrument. *Journal of Educational Psychology*, 66, 296–303.
- Levin, J. R., & Lesgold, A. M. (1978). On pictures in prose. *ECTJ*, 26, 233–243.
- Levin, J. R., & Mayer, R. E. (1993). *Understanding illustrations in text*. In B. K. Britton, A. Woodward, & M. Binkley (Eds.). *Learning from textbooks: Theory and practice*. Hillsdale, NJ: Erlbaum.
- Lichty, T. (1989). *Design Principles for Desktop Publishers*. Glenview, IL: Scott Foresman and Co.
- Lidman, S., & Lund, A.-M. (1972). *Berätta med bilder*. Stockholm: Bonniers.
- Liljestrand, B., & Arwidson, M. (1989). *Skrivstrategi*. 2nd ed. Stockholm: Esselte Studium.
- Limburg, V. E. (1987). *Visual "Intrusion": A Two-Way Street in Visual Literacy*. Paper presented at the IVLA Symposium on Verbo-Visual Literacy: Research and Theory. Stockholm, June 10–13.
- Lindell, E. (1990). *Läromedel i grundskolan – attityder och effekter*. Stockholm: Skolöverstyrelsen. F 909:4/Vad säger forskningen?
- Linderholm, I. (1997). *Målgruppen och budskapet. En modell för målgruppsanalys och utformning av budskap om trafiksäkerhet till unga manliga trafikanter*. Lund Studies in Media and Communication 3. Lund University Press: Lund.
- Lingons, B. (1987). *Rapporter från Stockholms Skolor. Läromedelsituationen i några Stockholmsskolor 1986/1987*. Stockholms skolförvaltning 1987: 4.
- Lindsay, P. H., & Norman, D. A. (1977). *Human information processing*. New York: Academic Press.
- Little, W. (Ed.). (1965). *The Shorter Oxford English Dictionary on Historical Principles*. Oxford: Clarendon Press.
- Lodding, K. (1983). Iconic interfacing. *Computer Graphics and Applications*, 3, 2, 11–20.
- Loftus, E. F. (1996). *Eyewitness Testimony*. Cambridge, MA: Harvard University Press.
- Loftus, G. R. (1972). Eye fixations and recognition memory for pictures. *Cognitive Psychology*, 3, 521–551.
- Loftus, G. R., Shimamura, A., & Johnson, C. A. (1985). How much is an icon worth? *Journal of Experimental Psychology: Human Perception and Performance*, 11, 1–13.
- Lotman, J. (1973). *Die Struktur des künstlerischen Textes*. Frankfurt am Main.

- Loveless, R. (1992). Open the Window to the 21st Century by Chancing a Romance with Contemporary Media Forms: A Challenge for the Arts in Higher Education. In Norman C. Yake (Ed.). *The Future: Challenge of Change*. Reston, VA: National Art Education Association.
- Lucas, F. D. (1977). Fifth-grade children's preferences for illustrations in middle grade basal reading materials. *Dissertation Abstracts*, 38, 3270–3271.
- Lowe, R. (1993). Diagrammatic information: techniques for exploring its mental representation and processing. *Information Design Journal*, 7 (1), 3–17.
- MacBeth, D. R. (1974). *Classificational Preference in Young Children: Form or Color*. Chicago: National Association for Research in Science Teaching. (ERIC Document Reproduction Service No. ED 092–362).
- MacDonald-Ross, M. (1977). How numbers are shown: A review of research on the presentation of quantitative data in texts. *AV Communication Review*, 25 (4), 359–409.
- Malmberg, T. (1996). Critical Theory and Audiovisual Media. *Nordicom-Information om medie- och kommunikationsforskning i Norden*, 1, 19–22.
- Mandl, H., & Levin, J. R. (Eds.). (1989). *Knowledge acquisition from text and pictures*. Amsterdam: Elsevier.
- Marsh, P. O. (1983). *Messages That Work: A Guide to Communication Design*. Englewood Cliffs, NJ: Educational Technology Publications.
- Massoumian, B. (1989). Successful teaching via two-way interactive video. *TechTrends*, 34 (2), 16–19.
- Matsushita, K. (1988). A summary version of the Comprehensive Report on Hi-OVIS PROJECT Jul.'78-Mar.'86. Tokyo: New Media Development.
- Mayer, R. E. (1984). Aids to text comprehension. *Educational Psychology*, 19, 30–42.
- Mayer, R. E. (1989). Models for understanding. *Review of Educational Research*, 59, 43–64.
- Mayer, R. E. (1993). *Illustrations that instruct*. In R. Glaser (Ed.), *Advances in instructional psychology*, Volume 5. Hillsdale, NJ: Erlbaum.
- Mayer, R. E., Steinhoff, K., Bower, G., & Mars, Rebecca (1995). A Generative Theory of Textbook Design: Using Annotated Illustrations to Foster Meaningful Learning of Science Text. *ETR&D*, 43, 31–43.
- McDougall, A. (1990). *Picture editing & layout a guide to better visual communication*. Viscom Press. School of Journalism. University of Missouri. Columbia.
- Media Literacy. (1998). <http://www2.tvo.org/education/pdvt/tfr/medialiteracy.html>.
- Melin, L. (1986a). *Text, bild, lexivision. En studie i text-bild-samverkan i en lärobok*. Stockholm: Stockholm University, Department of Nordic Languages.
- Melin, L. (1986b). *Termer – Ett kompendium om terminologi och termbildning*. Stockholm: Stockholm University, Department of Nordic Languages.
- Melin, L. (1992). *Lätt eller svårt. Ett kompendium om begriplighet i text*. Stockholm: Stockholm University, Department of Nordic Languages.
- Melin, L., Melin, S., & Eriksson, D. (1986). *Effektiv svenska för tekniker*. Stockholm: Natur och Kultur.
- Melin, L., & Pettersson, R. (1991). *Bildtexter i läroböcker*. Stockholm: Stockholm University, Department of Nordic Languages.
- Mellander, K. (1993). *The Power of Learning. Fostering Employee Growth*. Homewood, IL: The American Society for Training and Development.

- Messick, S. (1970). The criterion problem in the evaluation of instruction: Assessing possible, not just probable, intended outcomes. In M. C. Wittrock & D. E. Wiley (Eds.). *The Evaluation of Instruction: Issues and Problems*. New York: Holt.
- Metallinos, N. (1990) Class Syllabus: COMS 444: Television Aesthetics 1.
- Metallinos, N. (1997). *The Transformation of the Biological Precepts into Mental Concepts in Recognizing Visual Images*. Presentation at the 29th Annual Conference of the International Visual Literacy Association. University Park, Pennsylvania, October 18–22.
- Mijksenaar, P. (1997). *Visual Function. An Introduction to Information Design*. 010 Publishers: Rotterdam.
- Mijksenaar, P., & Westendorp, P. (1999). *Open Here The Art Of Instructional Design*. London: Thames & Hudson Ltd.
- Miles, J. (1987). *Design for Desktop Publishing*. San Francisco: Chronicle Books.
- Miller, G. A. (1956). The magical number seven, plus or minus two: Some limits on our capacity for processing information. *Psychological Review*, 63, 2, 81–97.
- Misanchuk, E. R. (1989). *Learner Preferences for Typeface (font) and Leading in Print Materials*. Saskatoon, SK: Division of Extension and Community Relations, The University of Saskatchewan. (ERIC Document Reproduction Service No. ED 307 854). Cited by E. R. Misanchuk (1992). *Preparing Instructional Text: Document Design Using Desktop Publishing*. Englewood Cliffs, NJ: Educational Technology Publications.
- Misanchuk, E. R. (1992). *Preparing Instructional Text: Document Design Using Desktop Publishing*. Englewood Cliffs, NJ: Educational Technology Publications.
- Modreski, R. A., & Gross, A. E. (1972). Young children's names for matches to form-color stimuli. *Journal of Genetic Psychology*, 121, 2, 283–293.
- Mok, C. (1996). *Designing Business*. Adobe Press: San Jose, California.
- Monfils, B. S. (1993). *Privacy in the Computer Age: Perceptions and Realities*. Presentation at the 3rd International Symposium of the International Visual Literacy Association. Verbo-Visual Literacy: Understanding and Application of new Educational Communication Media Technologies. Delphi, Greece, June 26–29, 1993.
- Moore, D. M., & Dwyer, F. M. (Eds.). (1994). *Visual literacy: A spectrum of visual learning*. Englewood Cliffs, NJ: Educational Technology Publications.
- Moore, J. F., & Moore, D. M. (1984). Subliminal perception and cognitive style in a learning task taught via television. *British Journal of Educational Technology*, 15, 3, 22–31.
- Moray, N. (1970). *Attention*. New York: Academic Press.
- Morgan, R. M. (1978). Educational Technology—adolescence to adulthood. *Educational Communication and Technology Journal*, 26, 142–152.
- Moriarty, S. E. (1991). *Creative Advertising. Theory and Practice*. Englewood Cliffs, NJ: Prentice Hall.
- Moriarty, S. E. (1994). Visual Communication as a Primary System. *Journal of Visual Literacy*, 14, 2, 11–21.
- Morley, D. (1992). *Television, Audiences and Cultural Studies*. London: Routledge.
- Morris, D. (1985). *Body Watching. A Field Guide to the Human Species*. London: Jonathan Cape Ltd.
- Muffoletto, R. (1987). *Critical Viewing-Critical Thinking: Reading the Visual Text*. Paper presented at the IVLA Symposium on Verbo-Visual Literacy: Research and Theory. Stockholm, June 10–13.
- Mullet, K., & Sano, D. (1995). *Designing Visual Interfaces Communication Oriented Techniques*. Mountain View, California: SunSoft Press A Prentice Hall Title.

- Murch, G. M. (1983). Perceptual considerations of color. *Computer Graphics World*, 6, 7, 32–40.
- Murray, F. B., & Mosberg, L. (1982). *Cognition and Memory*. In H. E. Mitzel (Ed.). *Encyclopedia of Educational Research* (5th ed.). New York: The Free Press.
- Möijer, K. (1987). *Skapa Skriva. Att växa i språket*. Stockholm:Esselte Studium.
- Nakayama, K., He, Z. J., & Shimojo, S. (1995). *Visual Surface Representation: A Critical Link between lower-level and Higher-level Vision*. In S. M. Kosslyn & D. N. Osherson (Eds.). *Visual Cognition, An Invitation to Cognitive Science*, Second Edition. MA: MIT Press.
- Nelson, W. W., & Loftus, G. R. (1980). The functional visual field during picture viewing. *Journal of Experimental Psychology: Human Learning and Memory*, 6, 391–399.
- Nesbit, L. L. (1981). Relationship between eye movement, learning, and picture complexity. *ECTJ*, 29 (2), 109–116.
- Newell, A. (1990). *Unified theories of cognition*. Cambridge, MA: Harvard University Press.
- Nickerson, R. S. (1965). Short-term memory for complex meaningful visual configurations: A demonstration of capacity. *Canadian Journal of Psychology*, 19, 155–160.
- Norman, D. (1998). *The Design of Everyday Things*. New York: Basic Books.
- Otto, W., & Askov, E. (1968). The role of color in learning and instruction. *Journal of Special Education*, 2, 155–165.
- Paivio, A. (1971). *Imagery and the Verbal Process*. New York: Holt, Rinehart, & Winston.
- Paivio, A. (1978). A dual coding approach to perception and cognition. In H. L. Pick, Jr., & E. Saltzman (Eds.). *Modes of Perceiving and Processing Information*. Hillsdale, NJ: Lawrence Erlbaum Associates.
- Paivio, A. (1979). *Imagery and Verbal Processes*. Hillsdale, New Jersey: Lawrence Erlbaum Associates.
- Paivio, A. (1983). The empirical case for dual coding. In J. C. Yuille (Ed.). *Imagery, Memory, and Cognition* (pp. 307–332). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Paivio, A. (1986). *Mental representations: A dual coding approach*. Oxford, England: Oxford University Press.
- Paivio, A. (1991). Dual coding theory: Retrospect and current status. *Canadian Journal of Psychology*, 45 (3), 255–287.
- Paquin, R. L. (1999). *Competencies of Visual Literacy*. In R. E. Griffin, W. J. Gibbs, & B. Wiegman (Eds.). (1999). *Visual Literacy In An Information Age*. International Visual Literacy Association.
- Parker, R. C. (1988). *The Aldus Guide to Basic Design* (2nd ed.). Seattle, WA: Aldus Corporation.
- Pashler, H. (1995). *Attention and Visual Perception: Analyzing Divided Attention*. In S. M. Kosslyn & D. N. Osherson (Eds.). *Visual Cognition, An Invitation to Cognitive Science*, Second Edition. MA: MIT Press.
- Paterson, D. G., & Tinker, M. A. (1932). Studies of typographical factors influencing speed of reading: X. Styles of type face. *Journal of Applied Psychology*, 16, 605–613.
- Perfetti, C. (1977). *Language comprehension and fast decoding: Some psycholinguistic prerequisites for skilled reading comprehension*. In J. Guthrie, (Ed.), *Cognition, Curriculum, and Comprehension*. Newark, Delaware, International Reading Association.
- Persson, R. S. (1996a). Concert musicians as teachers: on good intentions falling short. In A. J. Cropley & D. Dehn (Eds.). *Fostering the growth of high ability. European perspectives*. Norwood, NJ: Ablex.
- Persson, R. S. (1996b). Studying with a musical maestro. A case study of commonsense teaching in artistic training. *Creativity Research Journal*, 9 (1), 33–46.

- Persson, R. S. (1997). *Annorlunda land. Särbegåvnningens psykologi*. Stockholm: Almqvist & Wiksell.
- Persson, R. S. (1999). *Vetenskaplig handledning*. Lund: Studentlitteratur.
- Pettersson, R. (1983). *Picture legibility, readability and reading value*. Paper presented at the 15th Annual Conference of the International Visual Literacy Association. Bloomington. Oct. Published in A. D. Walker, R. A. Braden, & L. H. Dunker (Eds.). (1984). *Enhancing human potential. Readings from the 15th Annual Conference of the International Visual Literacy Association*. Blacksburg, Virginia. 92–108.
- Pettersson, R. (1985). *Intended and Perceived Image Content*. Paper presented at the 17th Annual Conference of the International Visual Literacy Association. Claremont. Nov. 1–2. A shorter version published in: L.W. Miller (Ed.). 1985: *Creating Meaning. Readings from the Visual Literacy Conference at California State Polytechnic University at Pomona*. International Visual Literacy Association, Inc., 11–16.
- Pettersson, R. (1986). *Image–Word–Image*. Paper presented at the 18th Annual Conference of the International Visual Literacy Association. Madison, Wisconsin, Oct. 30–Nov. 2. Also presented at the Information Design Conference 3, at the University of Warwick, England, Dec. 15–17. Published in: *Journal of Visual Verbal Language*. Fall 1986, 6, 2, 7–21. Also published in: R. A. Braden, D. G. Beauchamp and L. W. Miller (Eds.). (1987). *Visible & Viable. The Role of Images in Instruction and Communication*. East Texas State University. Commerce. Texas, 165–181.
- Pettersson, R. (1989). *Visuals for Information, Research and practice*. Englewood Cliffs. NJ: Educational Technology Publications.
- Pettersson, R. (1990). Teachers, students, and visuals. *Journal of Visual Literacy*, 10 (1), 45–62.
- Pettersson, R. (1992). The Use of Visuals in Oral Presentations. *ETR&D*, Vol. 40 (2), 109–116.
- Pettersson, R. (1993). *Visual Information*. Englewood Cliffs. NJ: Educational Technology Publications.
- Pettersson, R. (1995). Combined Learning. *Axiom*, 5, 37–38.
- Pettersson, R. (1996). *Verbo-Visual Communication*. Presentation at the 4th International Research Symposium on Visual Verbal Literacy, Process and Product: Media Education in Praxis, The Rijkshogeschool, IJsseland, and the International Visual Literacy Association, Deventer, Holland, May 6–11, 1996. In T. Velders (Ed.). (1996). *Beeldenstorm in Deventer. Multimedia Education in Praxis. Selected Readings* (pp. 11–15). Deventer.
- Pettersson, R. (1997). *Verbo-visual Communication – Presentation of Clear Messages for Information and Learning*. Göteborg: Valfrid Publishing Association and Research Centre for Library and Information Studies, Göteborg University.
- Pettersson, R. (1998a). *Information Design and Learning*. Presentation at Vision Plus 5. Learning meets Information Design, Information Design meets Learning. International Institute for Information Design, Fachhochschul-Studiengänge-Vorarlberg, Austrian Federal Ministry of Science and Transportation, Ministry of Education and Art, UNESCO. Schwarzenberg, Vorarlberg, Austria, July 2–4, 1998.
- Pettersson, R. (1998b). *Beyond Literacy*. Presentation at InfoDesign98, Information Design & the Learning Society, Cambridge University, April 20–21, 1998.
- Pettersson, R. (1998c). *Information Design*. Västerås: Mälardalens Högskola Research & Reports. Opuscula Nr 36.
- Pettersson, R. (1999). *Design of Information Sets*. Presentation at the 13th Annual Visual Communication Conference 1999, Lake Tahoe, California, June 23–27.

- Pettersson, R., Carlsson, J., Isacson, A., Kollerbauer, A., & Randerz, K. (1984). *Color Information Displays and Reading Efforts*. (CLEA-Report No. 18a). Stockholm: Stockholm University, Department of Computer Science.
- Pezdek, K., & Stevens, E. (1984). Children's memory for auditory and visual information on television. *Developmental Psychology*, 20 (1), 212-218.
- Pines, M. (1986). Landscapes of the mind. In R. M. Poole (Ed.), *The incredible machine* (pp. 325-377). Washington, DC: National Geographic Society.
- Postman, N. (1979). *Teaching as a Conserving Activity*. New York: Delacorte Press.
- Potter, M. C., & Levy, E. I. (1969). Recognition memory for a rapid sequence of pictures. *Journal of Experimental Psychology*, 81, 10-15.
- Poulton, E. C., & Brown, C. H. (1968). Rate of comprehension of an existing teleprinter output and of possible alternatives. *Applied Psychology*, 52, 16-21.
- Preble, D., & Preble, S. (1989). *Artforms*. New York: Harper & Row.
- Pressley, G. M. (1977). Imagery and children's learning: Putting the picture in developmental perspective. *Review of Educational Research*, 47, 585-622.
- Pressley, G. M., & Miller, G. E. (1987). Effects of illustrations on children's listening comprehension and oral prose memory. In D. M. Willows & H. A. Houghton (Eds.), *The Psychology of Illustrations. Vol. 1*. New York: Springer-Verlag.
- Pylyshyn, Z. W. (1973). What the mind's eye tells the mind's brain: A critique of mental imagery. *Psychological Bulletin*, 80, 1-24.
- Pylyshyn, Z. W. (1979). Imagery theory: Not mysterious - just wrong. *Behavioral and Brain Sciences*, 2, 561-563.
- Ragan, T. J. (1988). *Foundations for a visual perceptual development curriculum*. In R. A. Braden, D. G. Beauchamp, & L. Miller (Eds.), *Visual Literacy in Life and Learning*. Blacksburg: Virginia Tech University.
- Ramsey, I. L. (1982). The influence of styles, text content, sex, and grade level on children's picture preferences. *The Journal of Educational Research*, 75, 237-240.
- Ramsey, I. L. (1989). Primary children's ability to distinguish between illustrative styles. *JVL*, 9 (2), 69-82.
- Reigeluth, C. M. (1983). *Instructional design: What is it and why is it?* In C. M. Reigeluth (Ed.), *Instructional design theories and models: An overview of their current status*. Hillsdale, NJ: Lawrence Erlbaum Associates.
- Reigeluth, C. M. (1987). *Instructional theories in action: Lessons illustrating selected theories and models*. Hillsdale, NJ: Lawrence Erlbaum Associates.
- Reinking, D. (1986). Integrating graphic aids into content area instruction: The graphic information lesson. *Journal of Reading*, 30 (2), 146-151.
- Rieber, L. P. (1994). *Computers, graphics, & Learning*. Madison: Brown & Benchmark Publishers.
- Ringom, B. (1988). *Tänk positivt*. Falun: Larson.
- Rolandelli, D. R., Wright, J. C., & Huston, A. C. (1985). *Children's Auditory and Visual Processing of Narrated and Non-narrated Television Programming*. Paper presented at the Annual Meeting of the International Communication Association.
- Rosenfeld, L. B., & Jarrard, M. (1986). Student coping mechanisms in sexist and nonsexist professors' classes. *Communication Education*, 35, 157-162.
- Roth, C. E. (1992). *Environmental literacy: Its roots, evolution, and directions in the 1990s*. Columbus, OH:ERIC/CSMEE. ED351201.

- Rouet, J.-F., Britt, A., Coirier, P., favart, M., & Perfetti, C. A. (1995). *Learning from multiple documents: effects of study perspective and source information*. Presentation at the 6th European Conference for Research on Learning and Instruction. European Association for Research on Learning and Instruction. Nijmegen, August 26–31.
- Rowland, G. (1993). Designing and instructional design. *Educational Technology Research and Development*, 41 (1), 79–91.
- Rowntree, D. (1966). *Basically Branching*. Macdonald, London.
- Rowntree, D. (1990). *Teaching through self-instruction. How to develop open learning materials* (2nd ed.). New York: Nichols Publishing.
- Rumelhart, D. (1981). *Schemata: The building blocks of cognition*. In J. Guthrie (Ed.). *Comprehension and Teaching: Research Review*. Newark, Delaware, International reading Association, 1981.
- Saettler, L. P. (1968). *A history of instructional technology*. New York: MacGraw-Hill.
- Saettler, L. P. (1990). *The evolution of American educational technology*. Englewood, NJ: Libraries Unlimited.
- Salomon, G. (1984). Television is “easy” and print is “tough”: the differential investment of mental effort in learning as a function of perceptions and attributions. *Journal of Educational Psychology* 76, 647–658.
- Samit, M. L. (1983). The Color Interface, making the most of color. *Computer Graphics World*, 7, 42–50.
- Saunders, D. (1999). *Twentieth-Century Advertising*. London: Carlton Books Ltd.
- Schiffman, C. B. (1995). *Visually Translating Educational Materials for Ethnic Populations*. Paper presented at the 27th Annual Conference of the International Visual Literacy Association. Chicago, Oct. 18–22. 1995. Published in: R. E. Griffin, D. G. Beauchamp, J. M. Hunter & C. B. Shiffman, (Eds.). (1996). *Eyes on the Future: Converging Images, Ideas and Instruction. Selected Readings of the International Visual Literacy Association*. International Visual Literacy Association.
- Schiller, H. A. (1987). *Visual literacy in ancient and modern man (part one)*. In R. A. Braden, D. G. Beauchamp, & L. W. Miller (Eds.). *Visible & Viable: The Role of Images in Instruction and Communication*. Commerce: East Texas State University.
- School of Design at Carnegie Mellon University. (1997). *Design @ Carnegie Mellon. Programs. Bachelor of Fine Arts. Communication Design*. <http://www.cmu.edu/cfa/design/programs/cd/cd.html>
- Schwartz, N. H. (1988). Cognitive processing characteristics of maps: Implications for instruction. *Educational and Psychological Research*, 7, 113–128.
- Scott, M, T., Kirsch, I, S., & Jenkins, L, B. (1998). *International Adult Literacy Survey*. <http://nces.ed.gov/spider/webspider/98053XXXXX.html>.
- Seels, B. A., & Richey, R. C. (1994). *Instructional technology: The definition and domains of the field*. Washington, DC: Association for Educational Communications and Technology.
- Senn Breivik, P., & Jones D. L. (1993). Information Literacy. *Liberal Education for the Information Age. Liberal Education*, 79 (1), 24–28.
- Selander, S. (1988). *Lärobokskunskap. Pedagogisk textanalys med exempel från läroböcker i historia 1841–1985*. Lund: Studentlitteratur.
- Seward Barry, A. M. (1994). *Perceptual Aesthetics and Visual Language*. In D. M. Moore, & F. M. Dwyer (Eds.). *Visual Literacy. A Spectrum of Visual Learning*. Englewood Cliffs, NJ: Educational Technology Publications.

- Shadrin, R. L. (1992). *Design & Drawing An Applied Approach*. Worcester, Massachusetts: Davis Publications, Inc.
- Shannon, C. E., & Weaver, W. (1949). *The Mathematical Theory of Communication*. Champaign, IL: The University of Illinois Press.
- Shepard, R. N. (1967). Recognition memory for words, sentences, and pictures. *Journal of Verbal Learning and Verbal Behavior*, 6, 156–163.
- Sims-Knight, J. E. (1992). To Picture or Not to Picture: How to Decide. *Visible Language*, 26 (3), 325–388.
- Sinatra, R. (1986). *Visual Literacy Connections to Thinking, Reading and Writing*. Springfield, Illinois, Charles C. Thomas.
- Skinner, B. F. (1953). *Science and human behavior*. New York: Macmillan.
- Sloan, M. (1971). *Picture Preferences of Elementary School Children and Teachers*. Ann Arbor, MI: University Microfilms.
- Smith, C. Z. (1998). The Questionable Uses of 19th Century Photographs in Visual Research: Wisconsin Death Trip as Case Study. *Journal of Visual Literacy*, 18 (1), 47–60.
- Smith, P. L., & Ragan, T. J. (1999). *Instructional Design*. Merrill, Prentice Hall. Columbus, Ohio.
- Sperry, R. (1973). *Lateral specialization of cerebral functions in the surgically separated hemispheres*. In F. J. McGuigan & R. A. Schoonever, (Eds.). *The Psychophysiology of Thinking: Studies of Covert Processes*. New York, Academic Press.
- Sperry, R. (1982). Some effects of disconnecting the hemisphere. *Science*, 217, 1223–1226.
- Squires, P., & Ross, R. G. (1990). *Literacy Requirements for Customer Service Jobs*. ERIC No ED328 802.
- Standing, L. (1973). Learning 10,000 pictures. *Quarterly Journal of Experimental Psychology*, 25, 207–222.
- Standing, L., Conezio, J., & Haber, R. N. (1970). Perception and memory for pictures: Single-trial learning of 2500 visual stimuli. *Psychonomic Science*, 19, 99, 73–74.
- Sterner, J. (1997). *Bruksanvisningar: Är de så dåliga? Kvalitetsaspekter på produktanvändning och bruksanvisningar*. Research Reports No 1997:7. Stockholm: Stockholm University, School of Business.
- Stern, R. C., & Robinson, R. (1994). *Perception and Its Role in Communication and Learning*. In D. M. Moore & F. M. Dwyer (Eds.). *Visual Literacy. A Spectrum of Visual Learning*. Englewood Cliffs, NJ: Educational Technology Publications.
- Strunk, W., & White, E. B. (1979). *The Elements of Style*. New York: MacMillan Publishing Co Inc.
- Strömquist, S. (1991). *Skrivprocess och skrivundervisning*. In G. Malmgren & C. Sandqvist (Eds.). *Skrivpedagogik* (pp. 27–50). Studentlitteratur.
- Sutton, R. E. (1992). *Information Literacy Meets Media Literacy and Visual Literacy*. Presentation at the 29th Annual Conference of the International Visual Literacy Association, Pittsburgh, Sept. 30–Oct. 4.
- Sweller, J., Chandler, P., Tierney, P. & Cooper, M. (1990). Cognitive load as a factor in the structure of technical material. *Journal of Experimental Psychology: General*, 119 (2), 176–192.
- Taylor, J. (1979). Sexist Bias in Physics Textbooks. *Physics Education*, 14, 277.
- Tedeschi, J. T., & Rosenfeld, P. (1980). *Communication in Bargaining and Negotiations*. In M. E. Roloff & G. R. Miller (Eds.). *Persuasion: New Directions in Theory and Research*. Beverly Hills, Ca.: Sage.

- Teleman, U. (1991). *Vad kan man när man kan skriva?* In G. Malmgren & C. Sandqvist (Eds.), *Skrivpedagogik* (pp. 11–26). Studentlitteratur.
- The Economist (1991). *Style Guide*. The Economist Books. London.
- Thiel, K. K. (1985). *Job-related basic skills*. ERIC digest, 42. No Ed259 212 85.
- Tinker, M. A. (1963). *The Legibility of Print*. Ames: Iowa State University Press.
- Tinker, M. A. (1965). *Bases for Effective Reading*. Minneapolis: University of Minnesota Press.
- Trollip, S. R., & Sales, G. (1986). Readability of Computer-Generated Fill-Justified Text. *Human Factors*, 28 (2), 159–163.
- Tröger, W. (1963). *Der Film und die Antwort der Erziehung*. München/Basel: Reinhardt.
- Tufte, E. R. (1983). *The Visual Display of Quantitative Information*. Cheshire, CT: Graphics Press.
- Tufte, E. R. (1990). *Envisioning Information*. Graphics Press: New Haven Connecticut.
- Tufte, E. R. (1997). *Visual Explanations*. Cheshire, New Haven Connecticut: Graphics Press.
- Twyman, M. (1982). The graphic presentation of language. *Information Design Journal*, 3 (1), 2–22.
- Törnqvist, K. (1974). Förtroendet till massmedierna. En opinionsundersökning i november–december 1973. *Psykologiskt försvar*, 63. Stockholm: Beredskapsnämnden för psykologiskt försvar.
- Uljens, M. (1992). *What is learning a change of?* Göteborg: Department of Education and Educational Research University of Göteborg. (1992: 01).
- UNESCO. (1995). *Co-operation on matters in Information Design*. Resolution 4.9 of the 28th General Conference of UNESCO, Paris.
- Velders, T. (1995). *Reading Images, approaches for Visual Literacy*. Paper presented at the 27th Annual Conference of the International Visual Literacy Association. Chicago, Oct. 18–22.
- Velders, T. (1996). *Art, Aesthetics and Advertisement. Three A, Three Graces or the Triad as Visual Metaphor*. In T. Velders (Ed.), *Beldenstorm in Deventer. Multimedia Education in Praxis. Selected Readings*. Deventer.
- Velders, T. (1999). *Introduction*. Presentation at the 5th Symposium on Verbo-visual Literacy: Information Design. Eskilstuna, Sweden, November 9–11.
- Vickery, B., & Vickery, A. (1987). *Information Science in theory and practice*. London, Butterworth.
- Vogel, D. R., Dickson, G. W., & Lehman, J. A. (1986). Driving the audience action response. *Computer Graphics World*, August.
- Wahlman, J., & Kindborg, M. (1991). *Interactive Communication*. Stockholm: The Multimedia-project at Nature's House.
- Walker, P. (1990). A lesson in leading. *Aldus Magazine*, March/April, 45–47.
- Wandersee, J. H. (1992). *The Graphic Representation of Biological Knowledge: Integrating Words and Images*. Presentation at the 24th Annual Conference of the International Visual Literacy Association. Pittsburgh, Sept. 30–Oct. 4.
- Ward, W. C., & Naus, M. J. (1973). *The Encoding of Pictorial Information in Children and Adults*. Princeton, New Jersey: Educational Testing Service. (ERIC Document Reproduction Service No. ED 085–073).
- Watford, G. (1983). Science education and sexism in the Soviet Union. *School Science Review*, Dec., 213–224.
- Weidenmann, B. (1988). Der flüchtige Blick beim stehenden Bild: Zur oberflächlichen Verarbeitung von pädagogischen Illustrationen. (The Careless View in the Case of Standing Picture.) *Zeitschrift für Lernforschung*, 16 (3), 43–57.

- Weinstein, C. E., & Mayer, R. R. (1986). *The Teaching of Learning Strategies*. In M. C. Wittrock (Ed.), *Handbook of research on teachers* (3rd ed.). New York: Macmillan Publishing Co.
- Waller, R. (1987). *The Typographic Contribution to Language: Towards a Model of Typographic Genres and Their Underlying Structures*. Reading: University of Reading, Department of Typography & Graphic Communication.
- Wendt, D. (1979). An experimental approach to the improvement of the typographic design of textbooks. *Visible Language*, 13 (2), 108–133.
- Wender, K. F. (1989). *Mental models for spatial knowledge*. In A. F. Bennet & K. M. McConkey (Eds.), *Cognition in Individual and Social Contexts*. Amsterdam: Elsevier.
- West, S. (1987). Design for desktop publishing. In the Waite Group (J. Stockford, Ed.), *Desktop Publishing Bible*. Indianapolis, IN: Howard W. Sams.
- White, J. (1987). *New Strategies for Editing and Design*. Presentations at Trialog 87, Stockholm.
- Wickens, C. D. (1980). The structure of attentional resources. In R. Nickerson (Ed.), *Attention and performance VIII*. Hillsdale, NJ: Erlbaum.
- Wickens, C. D. (1984). Processing resources in attention. In R. Parasuraman & D. Davis (Eds.), *Varieties of attention*. New York: Academic Press.
- Wickens, C. D. (1991). Processing resources and attention. In D. Damos (Ed.), *Multiple tasks performance*. London: Taylor and Francis.
- Wileman, R. E. (1993). *Visual Communicating*. Englewood Cliffs, NJ: Educational Technology Publications.
- Willows, D. M., & Houghton, H. A. (Eds.). (1987). *The psychology of illustration. Vol.1. Basic research*. New York: Springer-Verlag.
- Wilson, D. A., Reeves, A., & Gazzaniga, M. S. (1982). “Central” commisurotomy for intractable generalized epilepsy: Series two. *Neurology*, 32, 687–697.
- Winn, W. (1993). Perception principles. In M. Fleming & W. H. Levie (Eds.), *Instructional Message Design: Principles from the Behavioral and Cognitive Sciences* (2nd ed.). Englewood Cliffs, NJ: Educational Technology Publications.
- Witkin, H. A., Dyk, R. B., Faterson, H. F., Goodenough, D. R., & Karp, S. A. (1962). *Psychological Differentiation*. New York: John Wiley.
- Witkin, H. A., Moore, C. A., Goodenough, D. R., & Cox, P. (1977). Field-dependent and field independent cognitive styles and their educational implications. *Review of Educational Research*, 47, 1–64.
- Witkin, H. A., Oltman, P. K., Raskin, E., & Karp, S. A. (1971). *A manual for the group embedded figures test*. Palo Alto, CA: Consulting Psychologists Press.
- Wittrock, M. C. (1974). Learning as a generative activity. *Educational Psychologist*, 11, 87–95.
- Wittrock, M. C. (1989). Generative processes of comprehension. *Educational Psychologist*, 24, 345–376.
- Wolf, W. (1970). *A Study of Eye Movement in Television Viewing. Final Report*. Columbus: Ohio State University. (ERIC Reproduction Service No. ED 046 254).
- Woodward, A. (1993). Do illustrations serve an instructional purpose in U.S. textbooks? In B. K. Britton, A. Woodward, & M. Binkley (Eds.), *Learning from textbooks: Theory and practice*. Hillsdale, NJ: Erlbaum.
- Wright, P. (1968). Using tabulated information. *Ergonomics*, 11 (4), 331–343.
- Wright, P. (1982). A user-oriented approach to the design of tables and flowcharts. In D. H. Jonassen (Ed.), *The Technology of Text: Principles for Structuring, Designing, and Displaying Text*. Englewood Cliffs, NJ: Educational Technology Publications.

- Wright, P., & Fox, K. (1972). Presenting information in tables. *Applied Ergonomics*, 1 (4), 234–242.
- Yarbus, A. (1967). *Eye Movements and Vision*. New York: Plenum Press.
- Young, M. (1989). *The Technical Writer's Handbook*. University Science Books. Mill Valley, CA.
- Zachrisson, B. (1965). *Studies in the Legibility of Printed Text*. Stockholm: Almqvist and Wiksell.
- Zakia, R. D. (1985). Advertising and sexual ethic. *International Journal of Visual Sociology*, 3 (1), 42–58.
- Zettl, H. (1990). *Sight, Sound, Motion: Applied Media Aesthetics (2nd ed.)*. Belmont, CA: Wadsworth Publishing Co.
- Zimmer, A., & Zimmer, F. (1978). *Visual Literacy in Communication: Designing for Development*. Hulton Educational Publications Ltd., in cooperation with the International Institute for Adult Literacy Methods, Teheran.
- Zwaga, H. J. G., Boersma, T., & Hoonhout, H. C. M. (1999). *By way of introduction: guidelines and design specifications in information design*. In H. J. G. Zwaga, T. Boersma, & H. C. M. Hoonhout (Eds.). *Visual information for everyday use. Design and research perspectives*. Taylor & Francis: London, Philadelphia.

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