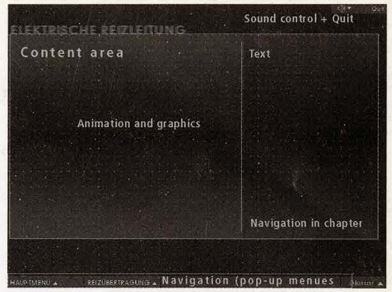
The use of digital media for knowledge presentation in education and knowledge management in business, raises two fundamental questions: the relation between design and cognition, and the role of audiovisualistic rhetoric – an, as yet, ill-defined field of consideration in design. This article addresses the question of how design can help to reduce cognitive complexity, produce clarity and contribute to transparency and understanding. It claims that a research policy should not aim exclusively at knowledge production, but should also take into account the process of knowledge distribution and assimilation. Design can assume a decisive role in these two phases of knowledge socialisation. It is able to structure and present knowledge so as to promote and facilitate effective absorption through the judicious application of combined resources from different domains: sound, music, movement, text and images. This application includes aesthetics as a constitutive domain and not simply as a add-on to usability. An example of software development for medical education is used to ground the proposal that design plays a catalytic role in the process of cognitive metabolism.



1.

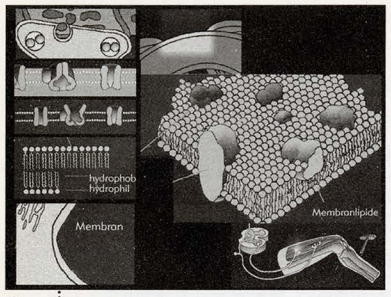
Design as Tool for Cognitive Metabolism

The Role of Design in the Socialisation of Knowledge

Gui Bonsiepe

Data, information, knowledge

In the discourse on information technology and information design there appears to be a 'progressivist linguistic chain – from "mere data" to "processed data" (information) to "verified information" (knowledge) to, perhaps, "existentially validated information" (wisdom?)' (Hakken 1999:21). Although concern has been voiced against a hidden ethnocentric bias behind this chain, I use the constellation of these four notions as a starting point in order to address the role that design can play in this process. In other words, I wish to offer tentative answers to the question of how design is involved when data are transformed into information and when information is transformed into knowledge. The title of the article implicitly claims a crucial cognitive role for design in everyday life, learning and management – a role that has become more evident with the expansion of information technology. The final, fourth level philosophical question of how knowledge is transformed into wisdom, I set aside for the moment. The background to my exposition is from various sources ranging from those that address the role of knowledge and knowledge management in organisations, to those that deal with the role of visualisation in enlightenment and in the transition from verbal to visual culture. I pursue an eclectic strategy for outlining the contour of the issue of design in relation to cognition – an issue that draws on the contributions of disciplines such as history, anthropology, computer sciences and cognitive psychology, to name but a few.



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A simple example serves to illustrate the process of transforming data into information and information into knowledge. Timetables may be characterised as lists of data. These raw – and that means unsystematised – data about train numbers, departure times, arrival times and routes become information when they are structured, that is when they pass from a state of high entropy to a state of low entropy. Here design intervenes by presenting data so that they can be perceived and received. Once the information has been organised it needs to be assimilated by an interpreter who knows what train connections are and who is, moreover, in a situation in which this information addresses a certain need. The next step in transforming information into knowledge occurs when a user internalises, interprets and uses the information, that is, translates information into action. It should be evident that the way data and information are presented is of crucial importance for enhancing understanding and facilitating effective action.

In everyday comprehension, knowledge is considered a phenomenon that is rooted in persons, which can also be externalised and deposited in the form of printed documents in data banks like libraries. Two representatives of the management sciences go one step further and offer the following characterisation:

> Knowledge is a fluid mix of framed experiences, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers. In organizations, it often becomes embedded not only in documents or repositories but also in organizational routines, processes, practices, and norms (Davenport & Prusak 1998:5).

Though I have certain reservations regarding this definition of knowledge as mainly instrumental or operational knowledge – leaving aside the hermeneutical domain – it brings into focus another feature that touches design: knowledge as accumulated experience needs to be communicated and shared between individuals. The process of communicating and sharing knowledge is linked to the presentation of knowledge – and the presentation of knowledge is, or could become, a central issue of design. At first sight it may not be obvious, or simply taken for granted, that the presentation of knowledge requires the intervention of design actions. Knowledge needs to be mediated by an interface so that it can be perceived and assimilated, accessed and experienced. This offers a leverage point for information design as an indispensable domain and tool in the communication and revelation of knowledge. Furthermore, the domain of information design is linked to the domain of education and learning. Learning and the design of learning may become a major business in the twenty-first century (Wurman 1999). This is good news. The bad news is that as yet we do not have a coherent theory of information:

> Today, in the Information Age, we are struggling to understand information. We are in the same position as Iron Age Man trying to understand iron. There is this stuff called information, and we have become extremely skilled at acquiring and processing it. But we are unable to say what it is because we don't have an underlying scientific theory upon which to base an acceptable definition (Devlin 1999:24).

Interaction

Although we lack an unequivocal and differentiated definition of 'information', we have a professional practice of information design in which contributions from cognitive psychology, linguistics, theory of perception, learning theory, semiotics and visual design[1] are integrated. In a recent publication on visualization, information design is defined as 'design of external representations to amplify cognition' (Card, Mackinlay & Schneidermann 1999:7) and understood as a domain of computer-based interactive representations. One could go a step further and say that visualisation means revealing generally invisible processes with the objective of facilitating and enhancing understanding.

The various scientific fields listed above are grouped around the fundamental concept of communication, which has been enriched with new possibilities by the technological development of interactive digital media. The interactive presentation of information is the major challenge facing traditional graphic design and other research-based disciplines today. Obviously, a book is also an interactive intellectual tool whose convenience has been proven throughout centuries, but interaction in the current more restricted sense refers to the presentation of information by means of digital documents such as CD-ROMs and www sites. In a prosaic sense then, interaction refers to a manner of presenting information to a community of users in a non-linear way, i.e. as hypertext or information in the form of netlike structures composed of semantic nodes with choices for movement through this net of nodes. Here presentation taps the resources of different perceptual channels, and can make use of new ways for presenting information, particularly scientific information, that thus far has been predominantly text- or print-based using static resources (typography and illustrations). Dealing successfully with these multi-channel aspects – sound, music, text, images, film, animation – requires different competencies that are brought together in teams composed of content providers who possess factual knowledge about specific domains.

Usability from a design perspective

Taking the team approach as a starting point for the development of digital documents and tools, the question is how we may characterise the professional responsibility of the designer in digital media. Looking at the numerous, some-

times conflicting, interpretations of design and its difference from engineering and the sciences, we can perceive a set of basic features or constants. I shall focus on only two. On the one hand, we have regard for the user, and on the other we have aesthetic quality. It is the focus on the user and her/his concerns from an integrative perspective that characterises the design approach and differentiates it from other disciplines (including ergonomics and cognitive sciences). Furthermore, a comprehensive design approach does not put aesthetics into quarantine, but explicitly addresses this quality with the inclusion of the dimension of play. At this point we enter an area of conflict. Usability is usually held to be the domain represented by the cognitive sciences, specifically the manner in which they deal with web design and carry the banner of usability engineering methods. In order to formulate this exclusive claim on the domain of usability, a rather narrow vision of web design is revealed. 'There are essentially two basic approaches to design: the artistic ideal of expressing yourself and the engineering ideal of solving a problem for a customer' (Nielsen 1999:11). In this dichotomy between art and engineering, between a self-centred focus and a client-centred focus, design does not even enter into consideration; it is simply swallowed up by usability engineering. Design vaporises into the status of a nonentity.

We may speculate about the reasons why this has happened. Perhaps it was caused by an understandable and justified reaction against 'cool' pages that are user-hostile though aesthetically captivating – the so-called killer sites. But that is hardly an issue. What is at state is an uncritical interpretation of usability that takes a complex notion for granted. Usability seems to be what usability engineering methods can measure. No designer would deny the necessity for the experimental testing of designs, but an understanding of usability that excludes the aesthetic domain becomes a blind victim of aesthetic choices that are made as a matter of course anyway. Through a process of self-censorship, a constitutive aspect in the use and daily experience of handling digital artefacts is excluded. This approach undermines its own relevance and usefulness for assessing web design projects. Concerns for formal quality cannot be disqualified as glitzy stuff to be pushed under the carpet because it is essentially difficult to assess or falls through the rough grid of usability engineering criteria. The claim that the way you get appropriate design ideas (and not just good ideas for cool designs that nobody can use) is 'to watch users and see what they like, what they find easy, and where they stumble' (Nielsen 1999:12) is anything but new. This is what designers usually do in their profession. Furthermore, it does not explain how appropriate innovations in design occur – it is a conservative and anti-dynamic stance. Having split the world into two opposite domains – explaining away design – innovative solutions are explained by referring to the *deus ex machina* in the form of 'inspiration' and 'creativity'.

My final criticism is directed towards the unilateral interest in the speed of finding information on a web site. This view overshadows the central issue that web and CD-ROM design serve to communicate and to enhance understanding. Of course, fast access to information is a desideratum, and slow sites with an excess of graphic components and distracting animations are a nuisance, but speed is not an absolute goal. Effective communication is.

Audiovisualistics

Effective communication depends on the use of resources that are intrinsically connected to aesthetics. These resources can be grouped under the heading of rhetoric – of course a revised and modernised rhetoric that reflects technological innovations. In classical understanding, grammar was concerned with formulating texts (speeches) in conformity with rules or formalised conventions, whereas rhetoric was concerned with embellishment (*ornatus*) and the reduction of *taedium*, i.e. rhetoric was a mechanism for preventing boredom and keeping the attention of the audience.

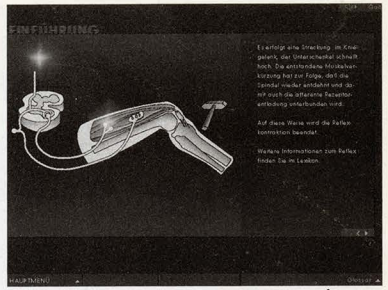
A characterisation of the role of the designer who designs information, could state that her/his contribution consists of reducing cognitive complexity, producing clarity, and contributing to transparency and understanding. This is achieved, amongst others, by the judicious application of the resources of visual rhetoric, or by better audiovisualistics that aim to keep the attention and maintain the curiosity of the user.

From knowledge production to knowledge distribution

Before commenting on an illustrative project that shows the role of design as a cognitive tool or as intellectual technology, I want to present a quote from a specialist of literary studies who makes – in my view – a bold proposal. We have all heard *ad nauseam* the lamentations about information overflow, information glut, information explosion, information saturation in our so-called information age and knowledge-based economies. But I will not indulge either in euphoric mantras of CR (computer revolution), nor in the opposite of information dystopists. The author writes:

> ... I am proposing that the great intellectual challenge of this Age of Information is not coming up with a grand unified theory in physics, or discovering the origins of human life. The great challenge is to be better served by what we already *know* (emphasis in the original) (Willinsky 1999:4).

Let me explain why I consider this proposal to be a bold one and particularly relevant for design. It sets new priorities for scientific research. Scientists are locked into the career-enhancing rite of publishing. Although few would object to the production of new knowledge as the main task of the sciences and scientific research, it should be kept in mind that this rite also has negative side effects. Keeping more or



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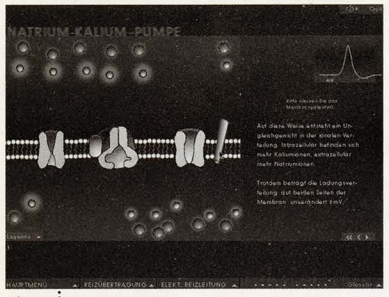

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less up-to-date in the different domains of knowledge has become almost impossible. For instance, Harvard University is cataloguing its subscriptions to more than 90000 serials. Historians now have some 5000 journals to carry and inform their work. Rather than investing huge resources unilaterally to produce new knowledge at an ever-increasing rate, we might consider redirecting some resources to ensuring that existing knowledge is made easily available and accessible. Richard Rorty is quite explicit in his recommendation:

> ... that sociologists and psychologists might stop asking themselves whether they are following rigorous scientific procedures and start asking themselves whether they have any suggestions to make to their fellow citizens about how our lives, or our institutions, should be changed (in Willinsky 1999:94).

It is at this point that designers can step in. They have – or are supposed to have – expertise in reducing cognitive complexity and helping to present information by designing an effective interface between information and reader. This new creed of designers runs under different labels like information architects (a term that I consider misleading, because it is static) or knowledge engineers (a term that I consider even more misleading with its macho-style connotations). I prefer the designation information design, a term favoured in continental discourse. Its objective is to facilitate cognitive metabolism.

Designers are not known for producing new knowledge – though there are exceptions. But designers can play a significant role in the presentation of knowledge. Information technology offers perspectives that Otto Neurath, considered one of the founding fathers of information design in the 1920s, could only dream about. Graphic design can become a decisive discipline with which to counter the so-called information explosion. It could become a discipline of considerable social relevance, though as I have mentioned, the term 'graphic design' has been undermined by technological developments.

Mappings

What are the epistemological and interpretative challenges facing designers when they become involved with information design? In order to answer this question I need to use concepts I consider of central importance for information design: the idea of the map and the activity of mapping. Again I wish to quote a concise formulation that clarifies what mapping is concerned with '... the map is perhaps the most sophisticated form yet devised for recording, generating and transmitting knowledge' (Cosgrove 1999:12). Maps do not depict a reality; they are not mimetic devices (in one of his writings Borges shows the absurdity of an enterprise to map a territory mimetically). Rather they reveal a reality. Acts of mapping comprise 'visualising, conceptualising, recording, representing and creating spaces graphically' (Cosgrove 1999:1). They do not create only physical spaces, but above all information spaces. Design faces the cognitive task of mapping, for instance, a loosely structured data bank of information consisting of texts, sketches, videos, photos, illustrations, diagrams, and animations about a topic in education, onto an interface that can be perceived, understood and acted upon by the user who wants to learn something. The design of information requires, firstly, giving structure to a mass of data and then translating these into the visual and auditory domain with a netlike pattern that can be navigated.

A case: software for medical education

In order to reinforce my claim for design as a cognitive tool, I shall give a synthesis of an information design project. It serves to show the approach, method and contribution of designers in developing course material in the form of a CD-ROM for medical students. The educational topic is the function of nerve cells, more precisely of cell membranes through which complex chemical and electrical processes pass on an atomic level. These complex invisible processes are difficult for students to master when relying only on texts with static illustrations. Understanding these processes is important because they illuminate, for example, the reasons why aspirin is effective.

The project commenced with a roughly ordered data bank consisting of sketches, texts and a general idea for a storyboard. The designers analysed and compared medical textbooks, collected material from sites, and analysed CD-ROMs for medical students. Once having acquainted themselves with the subject matter, the content was structured in detail, animation sequences were planned, illustrations were sketched, all texts were rewritten for readability on the monitor screen. A visual grammar was developed which allowed the testing of alternatives (colour schemes, appropriate type for screen presentations, lines, textures, digital treatment of photographs, types of illustrations, components for animation processes, and short movies).

The systematised data were then mapped onto an interface focusing on clear navigation, orientation and hyperlinks. Different animations were designed in detail. Video sequences were filmed. Texts were recorded for commentaries, and were sometimes reformulated by the content provider (a neurophysiologist) when he considered that certain issues required more detailed treatment. A glossary of technical terms and a set of exercises were added that allowed students to monitor and check their understanding of the material. Virtual tests were developed for measuring electrical potential, for instance, across different parts of a cell, and visualising these values on an animated graph. All digitised materials were imported into an animation program. The prototype was tested with medical students to assess the degree of acceptance, understanding and the

quality level of usability. The results of the testing served as feedback and input for a second round to polish the product.

The whole project presented a challenge not only in the visualisation of complex processes, but in proposing solutions that would enhance understanding and were articulated at a satisfactory level of visual literacy. It went considerably beyond what is understood as 'screen design'. It was an exercise that started with content as a diverse and loosely structured pile of facts and information and ended with a lucid and cogent communication of content. Knowledge has not only to be produced, but it has to be conveyed and understood. The example presented not only shows the role of design in the process of knowledge assimilation, but indicates that a successful research policy should not aim exclusively at knowledge production, but should also include knowledge communication and knowledge assimilation.

A minor research agenda

By way of conclusion, I wish to briefly comment on a research agenda. Compared with other domains, design is a scandalously under-researched field. I limit myself to mentioning three areas that can become fertile ground for design research.

1 History of design

In the context of information design and this article, design history should not be understood as a history of heroines and heroes, but as a history of innovations. In the literature of innovations, industrial design and graphic design are hardly considered as fields in which innovations occur apart from marginal aspects related to the form of products.

2 Audiovisualistic rhetoric

Classical rhetorical and semiotic studies have tended to focus on text and language, that is single media. Modern technology offers multimedia, that tap multichannel resources and offer options for moving through an information space by interactivity. We see a new culture in the making, but our tools for analysing and understanding the design aspects of this new culture are rudimentary and need to be updated. Critical understanding could assist us build up a wall against the avalanche of 'porridge speculations' that is formed largely by rhapsodic and somnolent deliberations about New Media.

3 Knowledge presentation, learning and management

Educational and business software analysed from a design perspective, which would explicitly include the power of audiovisualistic rhetoric, could lead to a better grounding of design work in this fast expanding field.

These are but a few topics that could be proposed to the institutions responsible for funding research. But in addition to funding, we need educational institutions that facilitate design research. I am afraid that our institutions of higher learning are not well prepared to deal with these challenges, because their management structures suffer from hundreds of years of tradition. It is evident that design research can only be done in teams with participants from different backgrounds. We will probably observe phenomena of 'intellectual migration': scientists moving into the field of design and designers moving into the field of sciences. That is an encouraging prospect.

NOTE

1. I prefer to use the term 'visual design' to the term 'graphic design' that is strongly associated with print technology.

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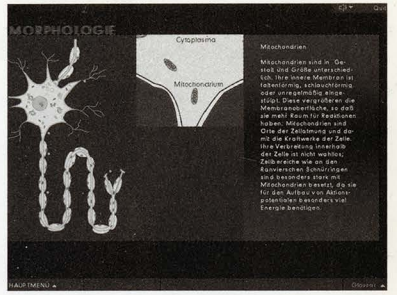
<http://www.useit.com/alertbox/>

<InfoDesign@wins.uva.nl> InfoDesign Newsgroup

<infodesign-cafe@list.design-inst.nl> InfoDesign-Cafe mailing list.

<webdev@ds.fh-koeln.de> Newsgroup on web development and web design



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Illustrations

Illustration 1: Layout structure of the screen (top area with chapter, main animation area, text column right, navigation bar below with pop-up menus.).

Illustration 2: Examples of the visual grammar for recognizability and visual coherence.

Illustration 3: Example of an illustration for animation with virtual experiment.

Illustration 4: Screen shot of an anmation (exchange of different ions with positive or negative charge through "pumps" in the membrane of the cell).

Illustration 5: Example for the use of a "lens". Moving the cursor over the figure on the left, a part is shown in amplification.