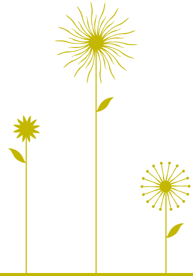

NATURAL METAPHORS

FOR INFORMATION VISUALIZATION

CAROLIN HORN

This thesis is submitted in partial fulfillment of the requirements for the degree of Master of Arts in Design and approved by the MFA Design Review Board of the Massachusetts College of Art in Boston.

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- -

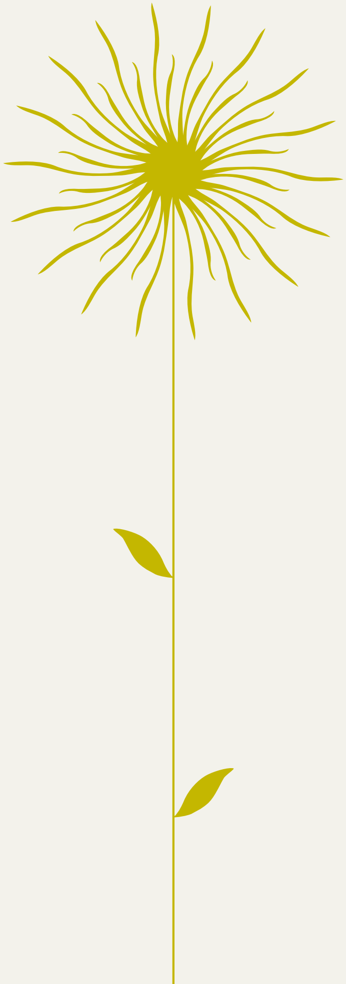
Brian Lucid, Thesis Advisor
Assistant Professor of Design
Dynamic Media Institute, Massachusetts College of Art, Boston

- -

Joe Quackenbush
Assistant Professor of Design
Dynamic Media Institute, Massachusetts College of Art, Boston

- -

Jan Kubasiewicz
Coordinator of Graduate Program in Design, Professor of Design
Dynamic Media Institute, Massachusetts College of Art, Boston



THANK YOU …

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ABSTRACT

My thesis research investigates how one can use metaphors of natural form and behavior for information to support a better understanding of data systems.

In everyday life we receive information mediated by behavior patterns and forms of appearance.
For instance, if someone is crying, we can infer that the person is sad or may be happy. We can interpret this kind of information and set it in context to the situation because of our previous experiences. This is part of our human perception and supports a better understanding of situations and information.

Users are confronted by constantly growing and changing amounts of data.
There is a need for new visualizations that support understanding of information and its dynamic nature.

I use natural metaphors to represent information. This includes the structure, navigation, interactivity, visualization and presentation of content. Visual and behavioral metaphors breathe life into information, creating rich, memorable experiences for users.

CONTENTS

INTRODUCTION

WHEN I WAS PREPARING FOR TESTS AT HIGH SCHOOL ...

I restructured and remodeled the learning material to study. I designed digests in the form of tree structures to visualize connections and the order of events. For instance, for an art history test, I designed an information graph of different art movements and their impact on each other. It helped me to recognize connections between certain information, to understand relationships, and as a result, to learn faster and easier. I did not know that this would be a part of my future job. Somehow, it was my introduction to information design.

At that time I visualized study materials to support my own personal learning; today I visualize data, to support the understanding of information for others. We are confronted by huge bodies of data during the search for particular information on the Internet or by our own data, which we collect on our personal computers. We are overstrained by the amount of data and its missing transformation to information.

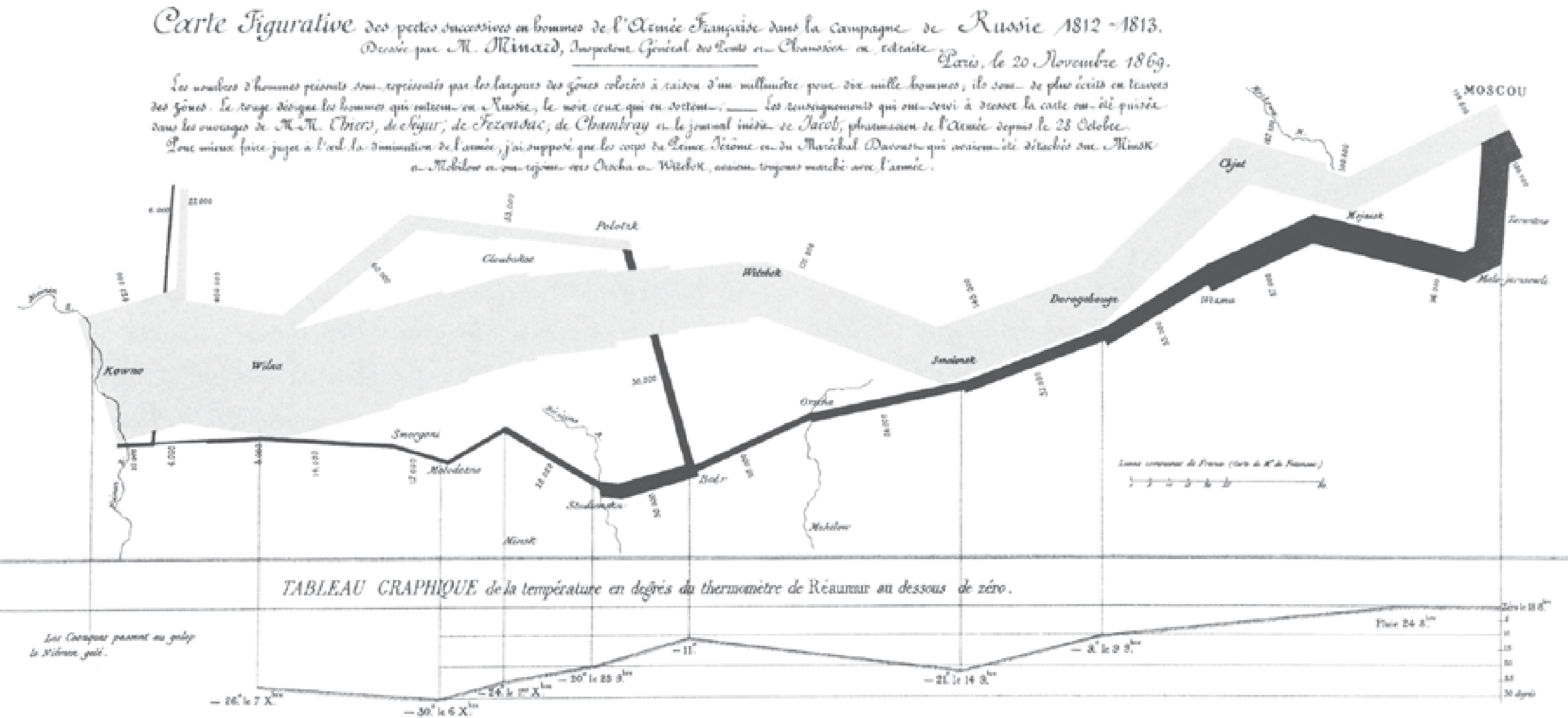
Information visualization helps us: it enables us to find, to select, to interpret and to understand information. Information visualization does not only involve the visual preparation of a particular content but also the visual preparation of data systems including the structure, navigation through, and interactivities with, these systems. Visualization can turn information into a more meaningful and richer experience.

INFORMATION VISUALIZATION

"Until recently, the term visualization meant constructing a visual image in the mind (Shorter Oxford English Dictionary, 1972). It has now come to mean something more like a graphical representation of data and concepts. Thus, from being an internal concept of mind, a visualization has become an external artifact supporting decision making" (Ware, 2004).

Information visualization is significant for several reasons. It conforms to our human affinity for visual information. We perceive about 75 percent of information visually. Information visualization enables us to perceive information fast, to understand a large amount of data, to understand complex processes and interrelations, to uncover trends and patterns within data systems, and finally to interpret data. Information visualization is used to represent: hierarchies and interrelations within a data system – to explain the structure of a subject, and how the subject may be related to something else; processes – how a subject is changing; functions – how a subject can be used; attributes – the qualities of a subject.

The significance of information visualization was known before computer-aided visualizations. A telling example is the visualization *Carte figurative des pertes successives en hommes de l'Armée Française dans la campagne de Russie 1812-1813* by Charles Joseph Minard (1781-1870). More than a hundred years ago he visualized Napoleon's Russian Campaign of 1812.


Carte Figurative des pertes successives en hommes de l'Armée Française dans la campagne de Russie 1812–1813.
Dressée par M. Minard, Inspecteur Général des Ponts et Chaussées en retraite.
Paris, le 20 Novembre 1869.
Les nombres d'hommes présents sont représentés par les largeurs des zones colorées à raison d'un millimètre pour dix mille hommes; ils sont de plus écrits en travers des zones. Le rouge désigne les hommes qui entrent en Russie, le noir ceux qui en sortent. — Les renseignements qui ont servi à dresser la carte ont été puisés dans les ouvrages de M.M. Thiers, de Ségur, de Fezensac, de Chambray et le journal inédit de Jacob, pharmacien de l'Armée depuis le 28 Octobre.
Pour mieux faire juger à l'œil la diminution de l'armée, j'ai supposé que les corps du Prince Jérôme et du Maréchal Davoust qui avaient été détachés sur Minsk et Mohilow et ont rejoint vers Orscha et Witebsk, avaient toujours marché avec l'armée.
MOSCOU
Kowno
Wilna
Smorgoni
Molodetschno
Gloubokoe
Polotzk
Witebsk
Studienska
Minsk
Bobr
Orscha
Mohilow
Smolensk
Dorogobouge
Wiazma
Chjat
Mojaisk
Tarantino
Malo-jarosewli
TABLEAU GRAPHIQUE de la température en degrés du thermomètre de Réaumur au dessous de zéro.
Les Cosaques passent au galop le Niémen gelé.
Zéro le 18 8bre
Pluie 24 8bre
— 9° le 9 9bre
— 21° le 14 9bre
— 11°
— 20° le 28 9bre
— 24° le 1er Xbre
— 30° le 6 Xbre
— 26° le 7 Xbre

“Beginning at the left on the Polish-Russian border near the Niemen River, the thick band shows the size of the army (422,000 men) as it invaded Russian in June 1812. The width of the band indicates the size of the army at each place on the map. In September, the army reached Moscow, which was by then sacked and deserted, with 100,000 men. The path of Napoleon’s retreat from Moscow is depicted by the darker, lower band, which is linked to a temperature scale and dates at the bottom of the chart. It was a bitterly cold winter, and many froze on the march out of Russia. As the graphic shows, the crossing of the Berezina River was a disaster, and the army finally struggled back into Poland with only 10,000 men remaining. Also shown are the movements of auxiliary troops, as they sought to protect the rear and the flank of the advancing army.

Minard’s graphic tells a rich, coherent story with its multivariate data, far more enlightening than just a single number bouncing along over time. Six variables are plotted: the size of the army, its location on a two-dimensional surface, direction of the army’s movement, and temperature on various dates during the retreat from Moscow” (Tufte, 2006). Minard’s visualization explains effectively the subject by filtering information and establishing relationships between different variables. It allows the user to recognize the changes over time of a particular variable like the size of the army and to understand causes of these changes by setting them in context to other variables like temperature. The comparison of different variables allows the reader to construct meaningful knowledge.

This visualization offers a rich experience for me. The information about losses in men is set in context to environmental conditions, which I can understand. I have experienced that -10 °C (14 °F) is too cold for me to be outdoors for longer time. I can imagine that a march at -30 °C (-22 °F) is a catastrophe. When I see how the band becomes thinner after crossing a river at this temperature, I can understand the dangerous situation for soldiers. This visualization connects information to my experiences; it creates pictures in my mind. The information is not abstract anymore; I can experience it through my imagination.

MY THESIS

NATURAL METAPHORS

My thesis research investigates how one can use metaphors of natural form and behavior to support a better understanding of data systems. I use natural metaphors to represent information. This includes the visualization of structure, the way of navigation and interactivity, and the presentation of content.

Metaphors are common methods of information visualization; it is the basic concept of most Graphical User Interfaces (GUI). The reason for using metaphors is to achieve an easier learning process for the user by using visual elements that are common in everyday life. Metaphors help to exemplify information; it becomes less abstract. “Images of common items leverage our knowledge of how those items function in the real world and, thus, suggest their function in the software environment” (Lidwell, Holden, and Butler, 2003). A metaphor can suggest more than a certain function: it can suggest a condition of a subject, for instance, whether it is old or new; it can suggest data structure and connection within a structure, for example, if a subject is a parent element like a folder or a child element like a document; or it can suggest a certain rating in a hierarchy, for instance, if a subject is more important than another one at the moment.

There are basically two different metaphors: visual and behavioral. Visual metaphors are static images as representatives of information, like the folder, document or trash can icons you have on a computer desktop. Behavioral metaphors are motions as representatives of information, like the jumping application icon in the dock of OS X, which tries to attract attention. In contrast to common GUI metaphors, which are often related to a working space environment, I use natural metaphors. These are metaphors for living organisms such as animals and plants, not inanimate objects such as stones. The reason for my choice is that I can meaningfully incorporate motion as a behavior into a "living" metaphor. Behaviors are activities used to communicate such as motion, posture, gesture, voice expression, or an activity which is a consequence of an emotion or instinct. Stones do not communicate, do not have emotions or instincts: therefore they cannot behave. Another reason is that we as humans respond to something that lives like an organism more emotionally than to something which lives like a stone. We are more emotionally involved because we get feedback to our action. For instance, a plant is growing when I water it; a dog is happy when I pet it. We are also more emotionally involved because we are able to relate to their behavior. We can interpret it because we partially identify with them. For instance, when a dog is running away from me, I can interpret his behavior as fear because I also run away when I am afraid. Natural patterns of behavior offer a range of possibilities for metaphorical use because a certain behavior indicates always a certain meaning and has a reason. For instance, if a dog is running away from me, it does not want to be close to me because it is afraid. Transferring this behavior to the computer environment, if information runs away from me, it does not want to be seen because it is not important for me at this moment. We are able to interpret and understand this behavior because we can make a connection to our experiences in the real world. Nature offers metaphors of continuum to illustrate conditions, changes, and structures of information. For instance, the birth, the development and the death of an organism can be used as a metaphor to illustrate the rise, the development, the dispersal, and the deleting of information. By having "live" metaphors, the user can connect emotions, experiences, which he has made with subjects in the real world to the digital representatives in the computer environment. The user can experience the information; the information becomes "alive". During a conversation, for example, an experience arises in the process of connecting visual and behavioral stimuli to interpret information. When we interact with other humans or animals, our communication is based on all types of stimuli including verbal, visual, and physical. For instance, when you are talking to me, I am observing your behavior and appearance to interpret your actual statement. My perception of information underlies a process: I observe, connect my observation to my previous experiences and, in the end, I am able to interpret the situation, to understand it. Participating in this natural process offers me a way to receive information as a lively, whole experience. I have the possibility to set information in context, to see it as a cause respectively as an effect of another one and therefore I am able to understand it better. By using natural metaphors I try to offer this kind of natural process of observation, connecting, interpretation to achieve similar experiences.

VISUALIZATION OF DATA SYSTEMS

“Increasing the visibility of the hierarchical relationships within a system is one of the most effective ways to increase the knowledge about the system” (Lidwell, Holden, and Butler, 2003).

I visualize data system structures, as well as connections and attributes of data within them. Thereby I unfold the information structure and use this visualization as the system navigation. I abolish the common separation between structure, navigation, and content. Commonly, in web sites, the menu is visually separated from the content. By abolishing this separation, I try to use navigation as an active element of information mediation. Navigation can become an experience instead of a simple act of necessity. Navigation elements allow users to move from one point to another within a content structure; they are the visible parts of a structure. For example, the content of common web sites is structured by main categories; these categories are offered as navigation elements. They give us an overview of offered information; they help us to orientate inside a structure; we use them to navigate to a particular content.
We can understand the structure through navigation.
By integrating structure, navigation and content, the user has the opportunity to establish relationships between different contents, to unfold hidden trends and patterns. The user can achieve a better understanding of structure and thereby is enabled to construct meaningful knowledge. My focus is on visualizations of different structures, the arrangements of data by different attributes, within one data system. For instance, the user can visualize the same data arranged by location, time, category, or hierarchy. By offering different structures, I can show the variety of interpretation possibilities of data. The kind of structure defines which information the user finally will get.

Each content set is unique, and subsequently demands a unique visualization, navigation, and interactivity that meets the requirements of its structure. Each subject has it's own logic that should be reflected in its interface. For instance, the handling of a motorcycle is different than the handling of a car. Understanding financial information is different than understanding shopping information, the mediation has to be adapted to the particular information, too. My visualizations are dependent upon the qualities of the actual data. This explains why my case studies are so different from one another – each deals with different data sets.

OBJECTIVES

We are confronted by constantly growing and changing data in which we have to orientate ourselves. We are continuously searching, filtering, finding and in the end, interpreting, information. There is need for new visualizations that support an intuitive understanding of information and its dynamic nature.

By visualizing data structures, I want to achieve a better understanding of data systems. And by using natural metaphors for information, I want to achieve an information mediation, which offers a richer experience.

COMPUTER-AIDED
INFORMATION VISUALIZATION

COMPUTER-AIDED INFORMATION VISUALIZATION

CHARACTERISTICS

Computer-aided visualizations use many design techniques and structure methods that were developed for print media to visualize information. For instance, data is arranged by location, alphabet, time, category, and/or hierarchy in printed and computer-aided visualizations. Visual codes like color, form and size are used as well to label, structure and visualize information in both media. But different media offer different possibilities to mediate and visualize information, as well as different possibilities for the user to perceive, understand, and interact with the information.

Multimedia (the simultaneous display of different mediums) is often said to be the main difference between print and computer-aided information visualization. But the term "multimedia" is problematic. Printed information visualization, employing text, photographs and illustration, can be also considered "multi" media. The difference between printed and computer-aided visualization isn't multimedia. One difference is that the computer offers a wider choice of media formats. Besides text, photograph and illustration, computer-aided visualization uses moving pictures and sound to mediate information. Another difference is that the multiple mediums of a computer are more transportable, more mobile than their analog counterparts, allowing for much greater ease and cost-effectiveness in distributing the information to consumers. Perhaps the most important difference is the fact that users can interact with computer-based visualizations. In print media, the designer alone decides how and what data is visualized. For example, he or she chooses if data is arranged by time or hierarchy.

A printed visualization is a finished product developed from previous design decisions. Creator and viewer are two different persons. In computer-aided visualizations the viewer becomes a co-creator. The user can customize different visualizations from the same data set. He can change the structure of data, he can filter, reduce or enlarge the amount of data, he can decide in which from information is mediated, such as sound, picture, animation. Visualizations are not static and hard-wired anymore but are dynamic and interactive. The designer defines the parameters of the user's freedom to manipulate visualizations; the user decides within his given freedom how and what data is visualized. "A graphic is no longer 'drawn' once and for all: it is 'constructed' and reconstructed (manipulated) until all relationships which lie within it have been perceived... a graphic is never an end in itself: it is a moment in the process of decision making" (Bertin, 1981). Digital media offers the possibility of visualizing real-time data. The base of dynamic visualizations can be data of a present condition. Visualization can change dynamically according to constantly changing data. Therefore the user cannot only see the past but also the present condition of a data set. Some visualizations mediate processes and time-based changes of data. In printed visualizations data from different points of time are often presented in one static picture or in several pictures side by side. Minard's visualization (see *Introduction*) is an impressive example of a visualization that mediates temporal changes in only one frame. The computer can mediate temporal changes in real time. Animations are used to show spacial motion of a subject and also change of quality and quantity of subjects. The dynamic and temporal pattern of changes can be visualized in real time: the user can recognize if changes are erratic or continuous, if changes are permanent, periodic or episodic, if the velocity is constant, accelerated or decelerated. In computer-aided visualization motion is an essential method to mediate information. The combination of real-time data and motion enables computer-aided visualization to visualize the dynamic of constantly changing data.

DEVELOPMENT OF THE GRAPHICAL USER INTERFACE

Today, we interact with computers constantly. We take the graphical user interface (GUI) as the primary method man-machine-communication for granted. We expect to use a mouse, to have graphic representations on screen, to use the computer as a tool to mediate, perceive, interpret and understand information. It was not always like this.

The development of the GUI was a long process, depending on technical developments and an increasing understanding of information visualization. Many different people and companies, like Xerox PARC and Apple, developed the graphic user interface over a long period of time. The development of the GUI was a major step for computer-aided information visualization. Developed concepts are the basis for current information visualizations. They are used for whole computer operating systems like OS X, for individual applications and tools like Photoshop, and for visualizations of individual subjects like data of stock markets.

The main developments were:

+ Hardware, which makes it possible to store, compute large bodies of data quickly and to show information visually
+ Pointer devices and concepts for interaction between human and computer, which make the preparation of and interacting with information easier (selecting, drag and drop, ...)
+ Visual representation of hierarchies, structures and content (menus, windows, documents, folders, applications, tools, ...)
+ Orientation principles (rollover, active and inactive condition of menu items, ...)

As these hardware and software features developed, so did conventions which determined how information was to be visualized and how users could interact with information. This constancy/familiarity is an important concept for information visualization: the user has to learn and understand a visualization system only once. The system becomes familiar; he knows where to look and what to do to find information. This constancy gives provides a sense of security and enhances the user experience. The same conventions developed by PARC, Apple, and others are still the basis for information visualization today.

Today designers use the computer as a tool to visualize all kinds of information, for instance an encyclopedia, the function of a device, the change of climate, and much more. Designers use developed conventions, like the desktop metaphor, as a basis for thinking about other possibilities of interactivity with, navigation through, and the presentation of information.

Joseph Nicéphore Niépce

FIRST PHOTOGRAPHY: STATIC PICTURE

1826

“Point de vue de la fenêtre” is said to be the first photography.

1895

Lumière Brothers

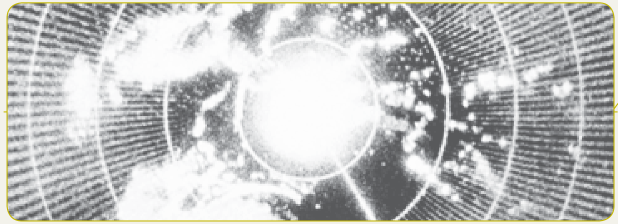
MOVIE: DYNAMIC PICTURES FROM THE PAST

The first time moving pictures, “La Sortie de L’Usine à Lyon”, were presented to a large paying audience.

1904

Christian Hülsmeyer

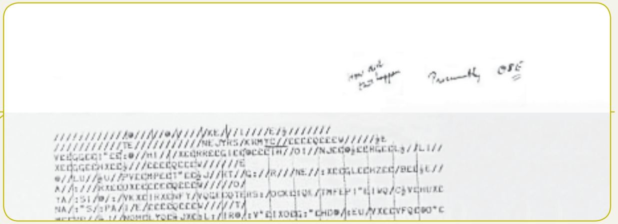
RADAR: REAL TIME SCREEN



Radar is a system that uses electromagnetic waves to identify the location, direction and velocity of moving and fixed objects such as planes and ships. During the Second World War radar was further developed to detect the presence of enemies. It is the first real time information visualization on screen.

Alan Turing

UNIVERSAL TURING MACHINE

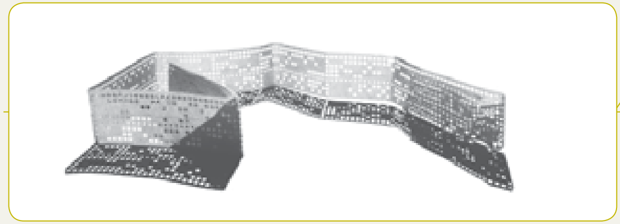


1936

The *Turing Machine* performed mathematical operations by reading and writing numbers on an endless tape.

Konrad Zuse

DIGITAL COMPUTER

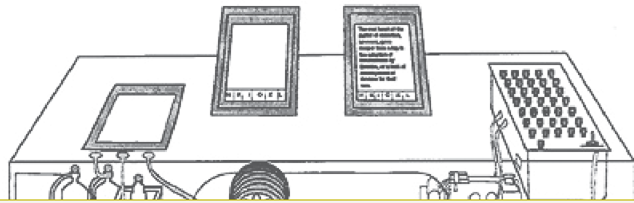


1941

Z3 was the first digital computer, which worked on the binary system instead of the decimal system. Punch tape was used to control computer programs. It is long strip of paper in which holes are punched to store data. Data is represented by the presence or absence of a hole in a particular location.

Vannevar Bush

CONCEPT: COMPUTER AS A PERSONAL TOOL FOR INFORMATION PROCESSING



1945

Even before the technology of personal computers was developed, Vannevar Bush looked into ideas and concepts of possible man-machine-communication. In his famous essay *As We May Think* (1945) he described the notional system *Memex*, which is said to be ancestor of all hypertext systems. It was the first concept which described the computer as a personal tool for information processing. "The *Memex* was to be a storage and retrieval device using microfilm.

It would consist of a desk with viewing screens, a keyboard, selection buttons and levers, and microfilm storage. Information stored on the microfilm could be retrieved rapidly and projected on a screen. The machine was to extend the powers of human memory and association. Just as the human mind forms memories through associations, the user of the *Memex* would be able to make links between documents. Bush called these associative trails"
(Griffin, 2007).

1945

Ivan Sutherland

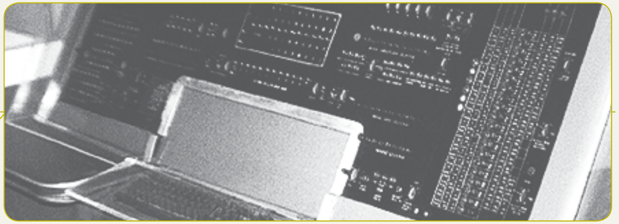
INTERACTIVITY IN REAL TIME: LIGHT PEN

The light pen is a computer input device, which is said to be the ancestor of the mouse. The user can point with this pen to displayed objects and change them in real time.

1951

John Mauchly and J. Presper Eckert

MAINFRAME UNIVAC I



Univac I was the first computer designed and sold commercially. The Census Bureau and the Pentagon used it for business data applications. Only 48 computers were built.

1957

Digital Equipment Corporation

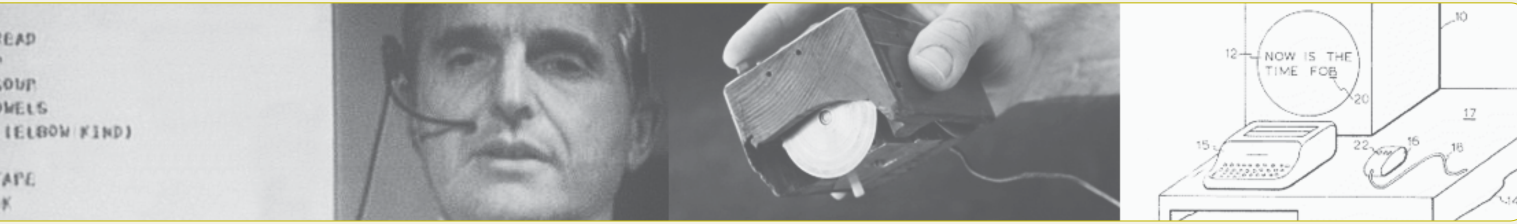
MINICOMPUTER PDP

Minicomputer *PDP* was the first commercial computer equipped with a keyboard and monitor.

Douglas Engelbart

FURTHER DEVELOPMENT OF MAN-MACHINE-COMMUNICATION

Inspired by Vannevar Bush's ideas and concepts, Douglas Engelbart published the famous essay *Augmenting Human Intellect* (1963). In this paper, he argued that computers could provide the quickest method to "increase the capability of a man to approach a complex problem situation, to gain comprehension to suit his particular needs, and to derive solutions to problems." He envisioned the computer not as a replacement for human intellect, but as a tool for enhancing it. His presentation in December 1969 is seen as *the mother of all demos*. He presented the mouse as the point deviser and introduced hypertext linking, full-screen document editing,

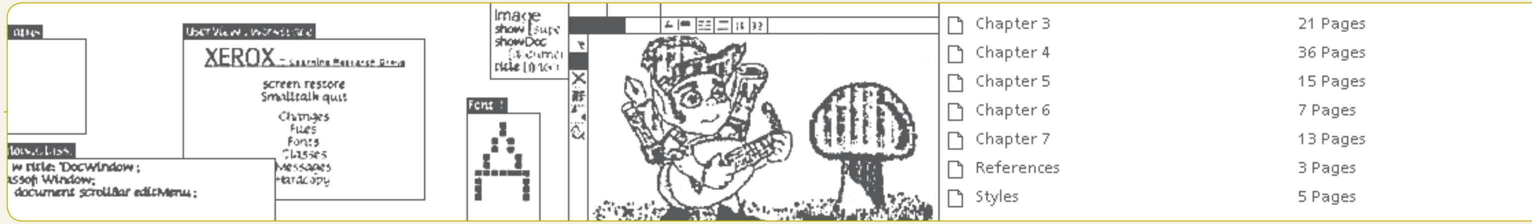


1963 -
1969

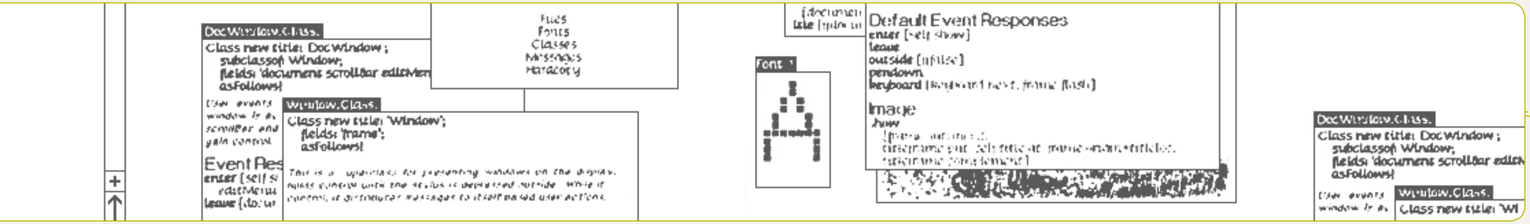
the copy and paste concept, and the window metaphor. The window metaphor in connection with the mouse changed how people thought about computers. "... Information space was transformed from an abstract idea into a landscape. In addition, Engelbart affords us representation in this landscape in the form of a cursor that is controlled by a mouse. The mouse provides us with the illusion of direct manipulation; instead of telling the computer to perform an action, we appear to do it ourselves" (Tropeano, 2001).

Xerox Palo Alto Research Center

THE "FIRST" GRAPHICAL USER INTERFACE

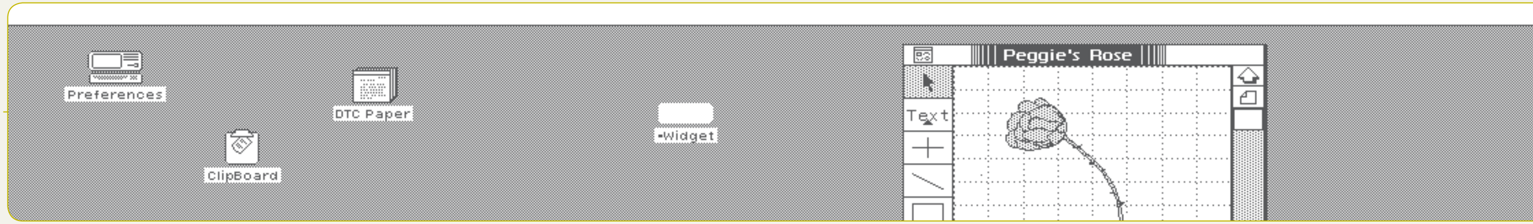


Inspired by Engelbart's concepts, Palo Alto Research Center (PARC) developed the computer *Alto*, which is seen as the first personal computer. The *Alto* was equipped with keyboard, modified version of Engelbart's mouse and a display, which had the same size and orientation as a printed page. The developers included a desktop publishing system in which the screen displays text as it will be printed – what you see is what you get. During the development the researchers realized the need for a consistent user interface to integrate all applications in one environment.
They created *Smalltalk*, the first modern graphical user interface.

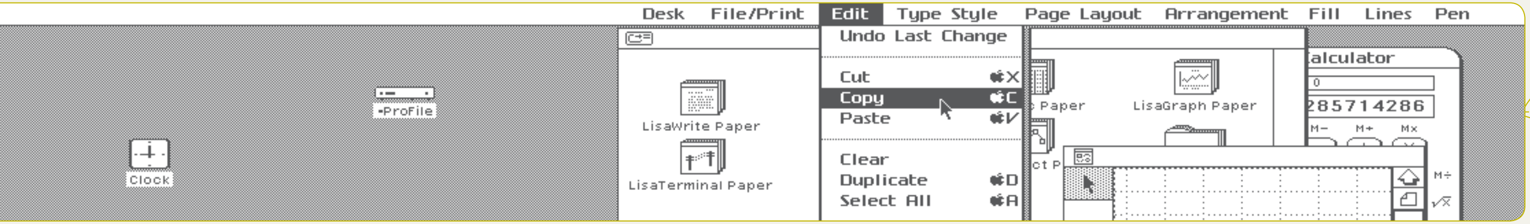


With *Smalltalk* PARC established many modern GUI concepts, like the desktop metaphor and the icon concept. The desktop metaphor transferred the familiar office desk more or less to the computer screen. There were files, documents and application icons as visual representations. The goal was to achieve an easier learning process for the user by using visual elements, which are common in everyday life. The first time there were overlapping windows, scroll-bars and popup menus. The combination of hardware (*Alto*) and software (*Smalltalk*) was a personal computer, even though it was never sold commercially.

FURTHER DEVELOPMENT AND COMMERCIAL IMPLEMENTATION



Inspired by PARC, Apple Computers developed the computer *Lisa* and continued with it the GUI development. *Lisa* was the first commercially sold computer to have a WIMP interface (Windows, Icons, Menu, Pointer). Apple concentrated on an icon-based interface and the desktop metaphor, which is the inherent part of software environments of most GUIs today. “The desktop is the primary metaphor for the Macintosh interface. It appears to be a surface on which people can keep tools and documents. Several other metaphors are integrated into the desktop metaphor. It makes sense in the context of a desktop environment to include folders



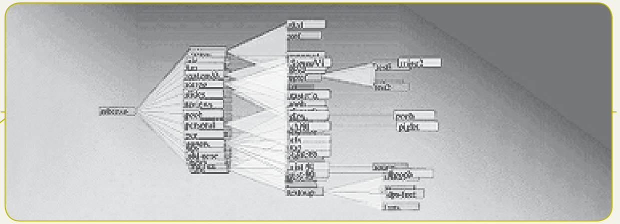
1979 -
1983

and a trash can (even though most trash cans do not sit on the desktop). Menus are an extension of the desktop metaphor. People can connect the idea of making choices from a computer menu with making choices from a restaurant menu. Although people do not keep restaurant menus on the edge of their desks, using the term menu in the computer environment reinforces the idea that people can use computer menus to make choices" (Apple Guideline, 1992). Apple developed the first GUI guidelines, which were demands for the design of graphical user interfaces. Each design of an application had and still has to follow them.

Xerox Palo Alto Research Center

CONE TREE

1991

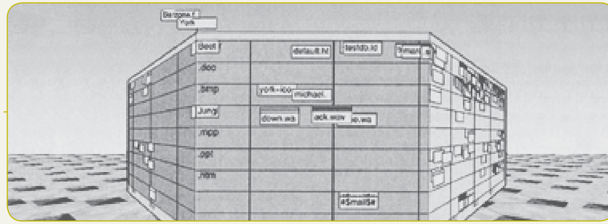


The Cone Tree visualization shows large hierarchies, like file system directory structure, by arranging its nodes in a 3-D space. Clicking on a node will cause the structure to rotate smoothly, bringing that node and its chain of ancestors to the front (Rao, 1996).

Xerox Palo Alto Research Center

PERSPECTIVE WALL

1991



The metaphor of a three dimensional wall is used to represent information structures. It is possible to arrange documents along the x- and y-axis to a linear criterion such as date, subject and author to reveal patterns and relationships.

James Wise, James Thomas, Kelly Pennock

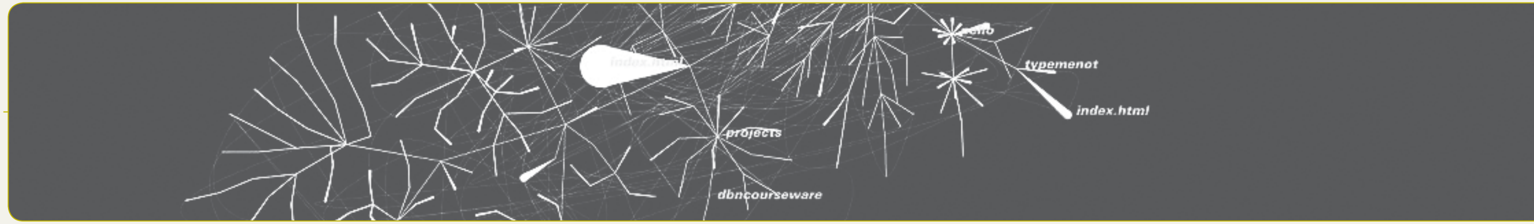
GALAXY

2004

The metaphor of a galaxy is used to visualize interrelations between the content of text documents. Each document is represented by one star. More similar documents are located next to each other. Theme clusters are formed.

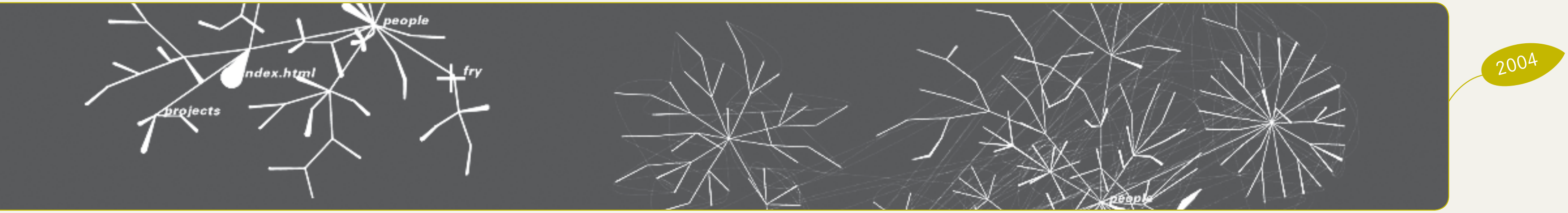
Ben Fry

ORGANIC INFORMATION DESIGN



The visualization of large bodies of quantitative and dynamic data is a special challenge. Techniques, which were successfully developed to visualize static information, are not sufficient to visualize huge dynamic systems like the changing structure of the Internet. In search of sensible methods to visualize such data systems, Ben Fry developed during his thesis at the MIT Media Laboratory a full automatic visualization process, which he defines as *Organic Information Design*.

He points to a parallel between attributes of simple organisms and requirements of dynamic data visualization. Stimuli, to which organisms react, are the basic concept – organic information visualization processes changes of dynamic data as stimuli and accordingly adapts to these (Fry, 2004). *Anemone* by Ben Fry is a famous implementation of organic information design. It visualizes how people use a web site via a visual metaphor of a branching, growing organism. Particular pages of a web site are represented as nodes,



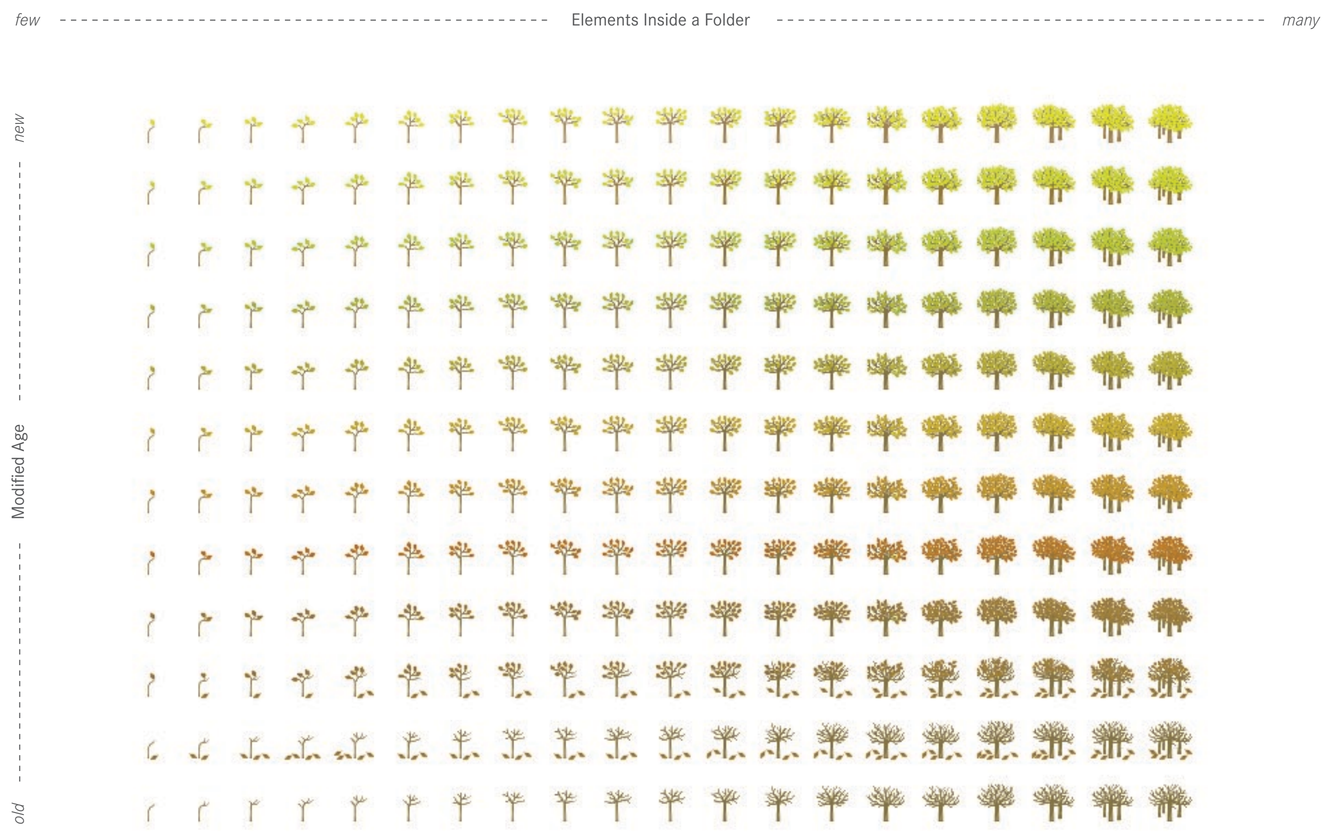
which are connected to each other by branches. These connections show the directory structure of the site and the hierarchic location of every page. Every time a user visits one page, its representative node becomes slightly thicker, so that the most visited pages are considerably thicker than the less visited ones. The user can click on a node to see the name of the page. He can also move parts of the organism to get a better view. A second information layer shows the main paths visitors follow inside the side structure.

The visualization was developed in Processing, an open source language based on Java programming language, which was developed by Ben Fry and Casey Reas at the MIT Media Laboratory. This application allows designers and artists without deep programming skills, like Java or C++, to code visuals and interactivities.

CASE STUDY
NATURAL ICONS

NATURAL ICONS

This case study was developed with the help of my advisor Prof. Jan Kubasiewicz in Spring 2007.
I created new folder and document icons for a graphical user interface. Usually metaphors of the work environment are used in modern operating systems: a piece of paper icon represents a document or a folder icon represents a folder. These icons help us to recognize and distinguish between the two basic structural elements of the GUI. But they cannot give us additional information about the represented element, like the modified date.

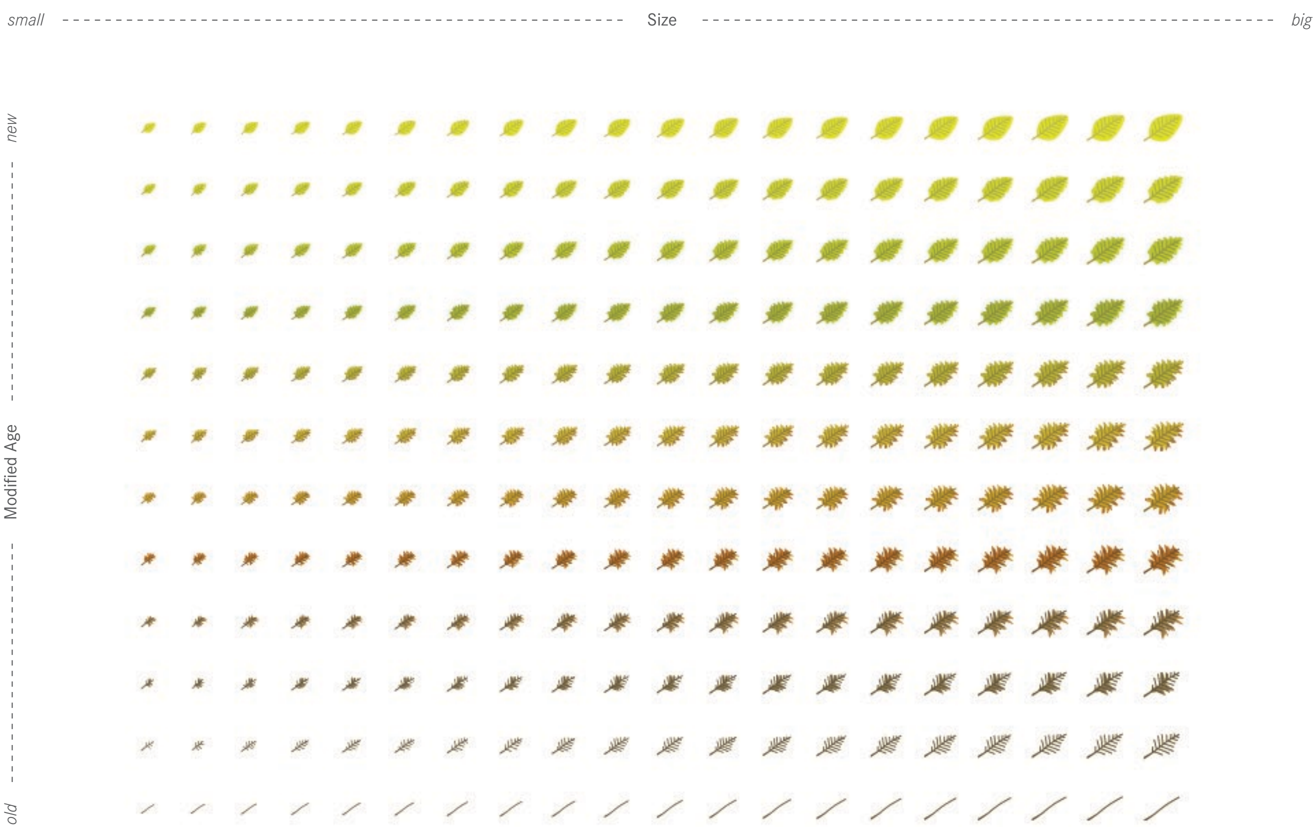

few
Elements Inside a Folder
many
new
Modified Age
old

FOLDER ICONS

A tree icon represents a folder.

The number of elements inside the folder is indicated by the growth of the tree: the more elements, the bigger the tree becomes. When the folder is huge, the tree becomes a little forest.

The age of the folder (modified date) is indicated by seasons. When the folder is new, the tree is bright green as it might be in spring. When the folder is old, the tree has lost all its leaves as it is in winter.


small
Size
big
new
Modified Age
old

DOCUMENT ICONS

A leaf icon represents a document.
The size of the leaf indicates the size of the document (in megabytes): the bigger a document, the bigger the leaf. The age of the document (modified date) is indicated by seasons, like the age of a folder.
When a document is new, the leaf is bright green. When a document is old, the leaf dissolves and only the stem remains.

INDICATION

The user does not obtain exact information from the icons, but rather, an indication about the folder and document's attributes. For instance, when he sees only leafless trees on his computer desktop, he can quickly recognize that he has not touched these folders for a while.

MY DEFINITION OF NATURAL

MY DEFINITION OF NATURAL

NATURE AND NATURAL

Nature (Latin: *natura* „to emerge", *nasci* „to be born") is defined generally as the phenomena of the physical world, which is not made by humans. It is divided into biotic nature like humans, animals, and plants and abiotic nature like stones, liquids, and fluids. The term is also used as a synonym for the mental and physical characteristic and entity of humans or animals. Something is natural for me when it belongs to nature. Opposites are artificial objects, concepts, and processes, procedures that are created by humans. I associate something pure, unmanipulated with natural world. A natural subject underlies a process such as growing and dying. Its form, motion, and behavior is conditional upon its environment. I associate dynamic with the natural world. I also use the word natural to describe processes or subjects which I feel as obvious and self-evident. In German the term natural is the synonym for "of course".

NATURAL FORMS

Natural form is physical appearance of a subject from nature, like the form of a tree. Opposites are forms of objects, which are made by humans in real life, like a trash can, and geometric, abstracted forms, which have no clear visible relation to a subject from nature, like a cycle. In design and also art, natural forms are used as decoration to achieve a certain "look and feel". For example, the Art Deco movement (1920-1939) used nature as its main inspiration. In information design, natural forms are used mainly to explain the actual natural object, for example visual explanation of an animal.

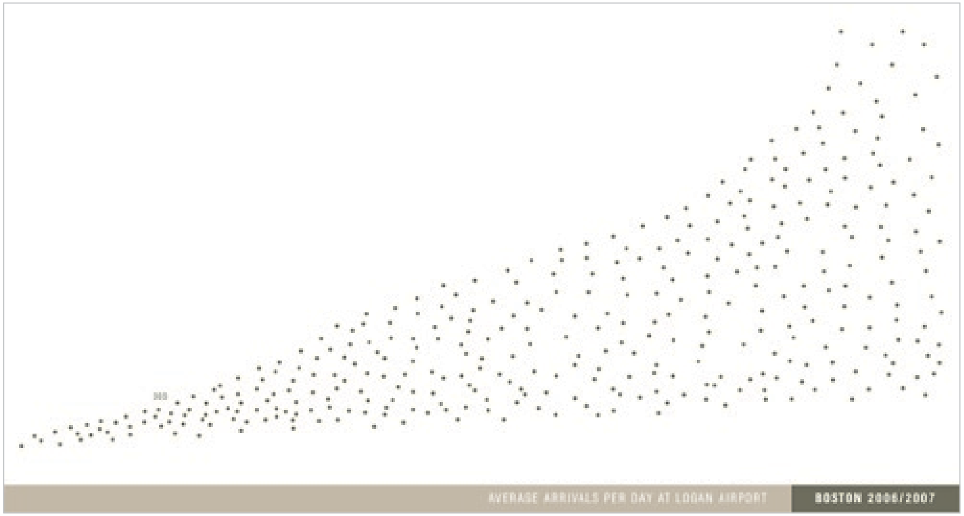
NATURAL MOTION

Natural motion is the change of position like walking or/and change of form like size of natural subjects. Natural motion is used in information design as inspiration and a model for animations. For example, it is used to visualize a process, development, and condition of natural subjects during an animated visual explanation.

NATURAL BEHAVIOR

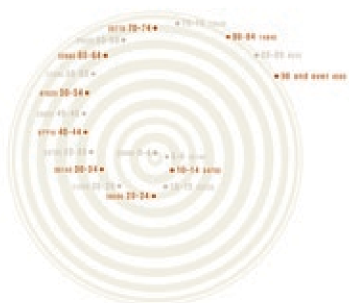
Behavior is defined differently depending on the area of expertise. I define natural behavior as follows: activities like motions, postures, gestures, voice expressions of humans and animals, which are used to communicate; or activities which are consequences of emotions and instincts. There is a difference between behavior and motion. Behavior is motion for the purpose of communication, like gestures. Behavior is motion as a consequence of an emotion, of an instinct. For example, it is a behavior when I cry as a consequence of sadness. It is motion when I have tears in my eyes as a consequence of cold wind. There are two different kinds of use in information design. First, the animated subject behaves like but does not look like the natural model, like jumping application icon in OS X. The animated behavior is disconnected from the physical appearance of the natural subject. The natural behavior is abstracted and is used to achieve the same effect as it has in "real life", for example to attract attention. Second, the animated subject behaves and looks like the natural model, for instance, to explain and visualize the behavior of certain animals.

CASE STUDY
PATTERN CARDS


AVERAGE ARRIVALS PER DAY AT LOGAN AIRPORT
BOSTON 2006/2007

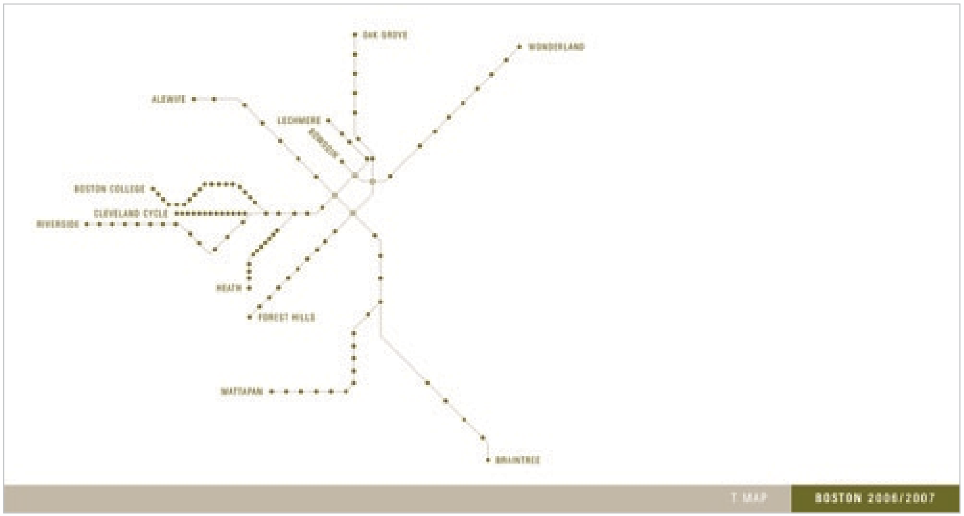
CITY STREET MAP

BOSTON 2006/2007



AGE RANGE

BOSTON 2006/2007


OAK GROVE
WONDERLAND
ALEWIFE
LECHMERE
BOWDOIN
BOSTON COLLEGE
CLEVELAND CYCLE
RIVERSIDE
HEATH
FOREST HILLS
MATTAPAN
BRAINTREE
T MAP
BOSTON 2006/2007

PATTERN CARDS

The case study was developed with the help of my advisor Prof. Joe Quackenbush in Fall 2006.
I manipulated a series of photographs to visualize information. For instance, a spider net is manipulated in a way that represents Boston's subway structure. The viewer does not notice at first glance that there is something wrong with the photographs. Only after a closer look or seeing the solution on the back can the viewer recognize the true content of these photographs.

PERCEPTION

PERCEPTION

Perception is the process of acquiring, selecting, organizing, and interpreting sensory information.
It is significant for information visualization. If we can understand how our visual perception works, we can use this knowledge for information design to produce better perceptible visualizations (Ware, 2004). Which elements are perceived faster than other elements? Which element attracts attention, which does not? How do we structure elements through perception? Which elements are perceived as groups, which are not? Human perception involves all senses: sight, hearing, taste, smell, and touch. In my research I have concentrated mostly on visual perception of information.

VISUAL PERCEPTION

Human perception and interpretation of information, like a daily object, depends on personal expectations, attitudes, goals, interests, and previous experiences. Everybody perceives and interprets the same information differently; the meaning of information is individual. Someone who has made bad experiences with dogs will perceive a dog differently than someone who has made only good ones. Additionally someone perceives and interprets the same object differently depending on his current needs, interests, and expectations. For instance, I perceive food differently depending on my current appetite.

Nevertheless the primary perception of objects, like object recognition, is based on a standardized visual system. According to Colin Ware, the director of the Data Visualization Research Laboratory at the University of New Hampshire, "The visual system has evolved over tens of millions of years to enable creatures to perceive and act within the natural environment. Although very flexible, the visual system is tuned to receiving data presented in certain ways, but not in others" (Ware, 2004). Because of this more or less standardized visual system, same visual concepts can affect humans in similar ways.

VISUAL PERCEPTION AS A STANDARDIZED SYSTEM

Colin Ware defines three main stages of perceptual processing (Ware, 2004). At the first stage, the visual field is analyzed in primitive elements like form, color, texture, orientation, and motion.
At the second stage, the visual field is divided into different regions based on same color, texture, contour, and motion. At the last stage, we can recognize an object by comparing it to memorized objects.

1. Stage: Analysis of Primitive Elements

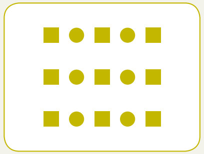
The first stage is a fast and unconscious process.
Information is processed by large arrays of neutrons in the eye and in the visual cortex of the brain. Billions of specialized neurons work parallel to extract features from the total visual field. In this process, the visual field is analyzed in primitive elements like form, color, texture, orientation, and motion to recognize contours. Lightness, brightness, contrast, color, constancy, and motion of elements are very important at this stage. The more an element differs from the environment the more it sticks out.

2. Stage: Finding Patterns

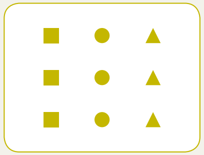
At the second stage, we divide the visual field into regions and patterns based on same color, texture, contour, and motion. The search for patterns is influenced by the massive amount of information available from stage 1 and by our attention driven by visual queries. These visual queries can be vague or precise. For example, it depends on whether we search for specific or several trends inside information visualization. The search for patterns is an active process to recognize the structure of visualization. According to Colin Ware, “Understanding pattern perception provides abstract design rules that can tell us much how we should organize data so that important structures will be perceived. If we can map information structures to readily perceived patterns, then those structures will be more easily interpreted” (Ware, 2004). “Berliner Schule”, a group of German psychologists, made the first attempt to understand pattern perception and formulated a series of gestalt laws in the end of the 19th century. These theories describe how the visual system perceives elements as groups, how we perceive patterns (for more details see next page).

3. Stage: Recognition of an Object

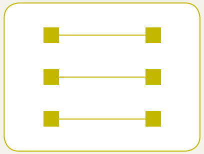
At the last stage information is reduced to only a few objects.
We recognize the object by comparing it to objects, which we have memorized before. When we find the fitting mental image of the object, we recognize it. At this stage, several brain subsystems, like verbal linguistics subsystems, process information in parallel.
For example, it enables us to connect a word to a perceived object. Memory is very important at this stage; it provides the basis for active cognition. There is the iconic, working, and long-term memory. The iconic memory is the visual short-term memory; pictures are memorized only one second. The visual working memory is defined as the visual information retained from one fixation to the next; we can memorize tree to five objects. The long-term memory contains all information which we have collected through experience, and learning. It is permanent knowledge storage. According to Colin Ware, new information can only be included if it can be connected to already existing knowledge (Ware, 2004).



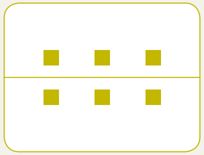
Proximity
Elements that are close together are perceived as a group.



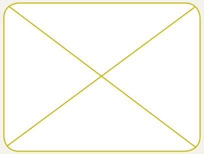
Similarity
Elements that are similar in color, form, size, motion are perceived as a group.



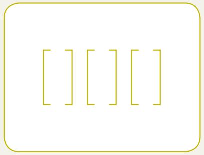
Connectedness
Elements that are connected to each other are perceived as a group.



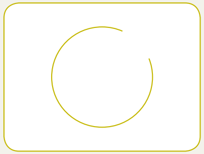
Common Region
Elements that are part of a larger region are perceived as a group.



Continuity
We tend to continue contours whenever the elements of the pattern establish an implied direction.



Symmetry
Symmetric elements are perceived as a group regardless of their distance.



Closure
We tend to perceive incomplete objects as complete. Our mind adds missing elements to complete a figure.

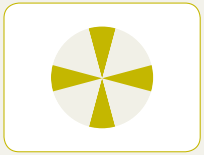
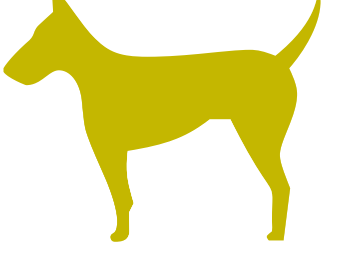


Figure and Ground
One element takes a prominent role (figure) while another recedes into the background (ground).

PERCEPTION OF STATIC REPRESENTATION

PERCEPTION OF STATIC PATTERN: PERCEPTION PRINCIPLES

These theories describe how the visual system perceives elements as groups, how we perceive patterns.



HUND

SENSORY AND ARBITRARY REPRESENTATIVES

In the theory of perception, representatives are divided into sensory and arbitrary.

Sensory Representatives

According to Colin Ware, "… the word sensory is used to refer to symbols and aspects of visualizations that derive their expressive power from their ability to use the perceptual processing power of the brain without learning" (Ware, 2004). He describes an experiment, which investigates whether humans can interpret pictures without previous experience (Ware, 2004): after Julian Hochberg and Virginia Brooks raised their daughter to the age of two in a house with no pictures, she was able to recognize most of the objects in line drawing pictures and photographs. The ability to recognize pictures and spatial perspectives is not based on conventions but we discover basic similarities between with picture and its counterpart in our environment. According to Colin Ware, we can immediately understand sensory representatives because their processing is hard-wired. For example, I can immediately recognize a tree and do not even think about it. Sensory representatives are often universally understandable because we all have the same visual system.

Arbitrary Representatives

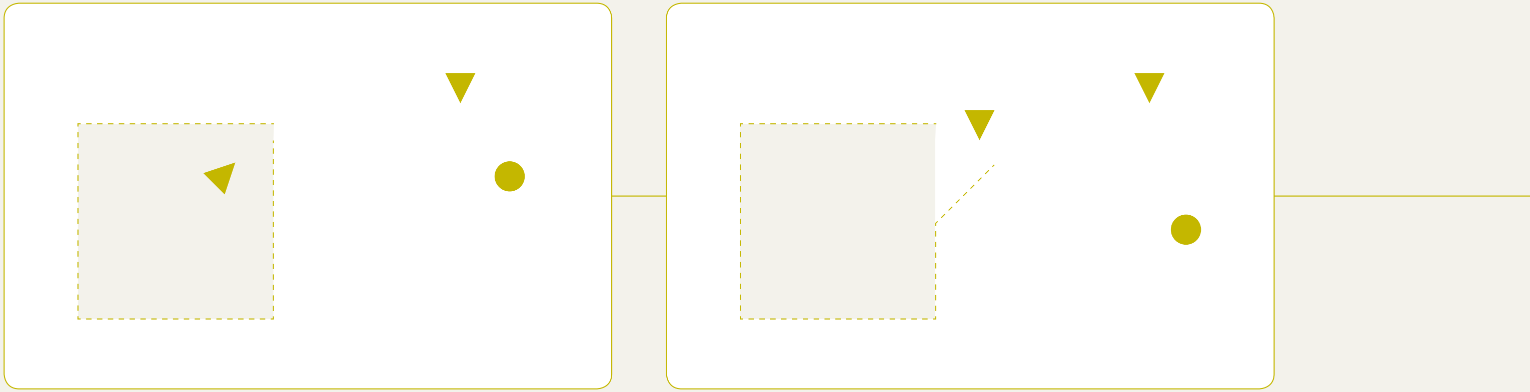
According to Colin Ware, "… the word arbitrary is used to define aspects of representation that must be learned, because the representations have no perceptual basis. For example, the written word dog bears no perceptual relationship to any actual animal" (Ware, 2004). The interpretation of arbitrary symbols requires a learning process and experience. For example, I still learn English and I started 14 years ago. Unless the meaning of arbitrary symbols is memorized through repetition, it can be easily forgotten – I unlearn English very fast when I am in Germany. The interpretation is culturally specific and is based on social conventions. Arbitrary symbols can be changed rapidly because they are created codes and not directly connected to our perception. They are socially constructed and therefore, replaceable. They can be constructed to embody powerful and compact languages such as mathematics.

PERCEPTION OF MOTION

Motion is defined as the change of position of a subject like walking. It is also the change of a subject's form like growing.
Humans recognize moving subjects faster than static subjects due to biological reasons. Movements and attached meanings are recognized and processed directly in human perception. For example, I perceive fast, abrupt movements as more dangerous than slow, even movements. This perception is necessary to recognize potential danger. Designers use often this perception characteristic to attract attention to a certain element, for instance the jumping application icon in the dock of OS X. Besides the faster perception, humans recognize movements, which are barely in the field of vision. These movements can attract our attention immediately and therefore we can concentrate on a larger field of vision.

We perceive motion as a combination of several attributes. Who is moving? How much does the form change by moving? How is the path of motion? Is it linear or circular? How fast does a subject move or change its form? Is there an abrupt change in motion or is it even? Where is a subject moving? How is the motion orientation related to another subject, does it move towards me? Does only the subject move or another subject, too? The perception of motion has certain characteristics. The size of a moving element influences the perception of velocity. Bigger elements seem to move slower than smaller elements even though they move in the same velocity.

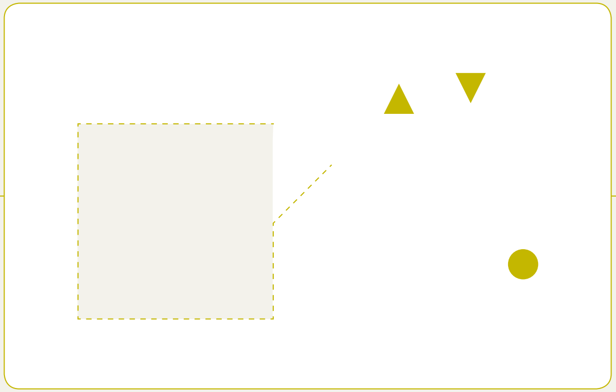
The structure of a background influences our perception of velocity. The velocity of an element is perceived faster on a structured than on a plain background. And we perceive and interpret motion of an element in context to other elements and the environment. Unlike static patterns, there are no general principles for motion patterns, which formulate how a motion can be used to achieve a certain meaning in information visualization. But according to Colin Ware, "... we are very sensitive to patterns in motion and, if we can learn to use motion effectively, it may be a good way to display certain aspects of data. (...) For purposes of data display, we can treat motion as an attribute of a visual object, much as we consider size, color, and position to be object attributes" (Ware, 2004). There are perception theories for motion. Elements, which are moving, tend to be grouped. Movement separates elements from the environment. Elements that change at the same time tend to be grouped. Elements moving at the same direction tend to be grouped. Elements moving in the same velocity tend to be grouped.

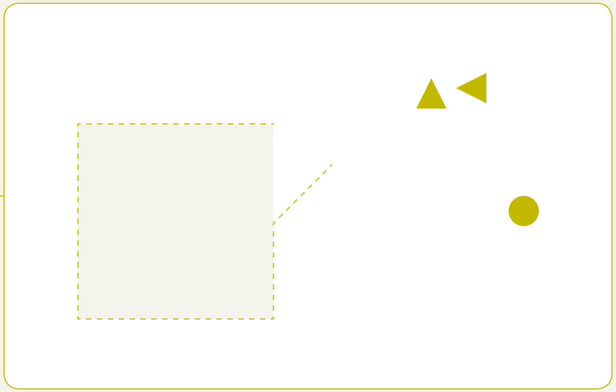


ANIMATED MOTION PERCEPTION

In the context of animated motion perception, the attribution theory is interesting. It was developed from the theories of social psychologists like Edward Jones, Fritz Heider, Keith Davis, and Harald Kelly. Attribution theory is concerned with how individuals interpret events. Attribution theory assumes that people try to determine why a subject (people, animal, and also objects) does what they do. For instance, if someone avoids eye contact, I wonder why. I may assume he is shy, angry, or conscious of guilt.

The interesting aspect of this theory is that we tend to attribute our own familiar behavior and motives to other subjects when we do not have an objective knowledge about them. You can also say, we project ourselves onto unknown subjects. When we approximate the unknown subject with ourselves, we believe we understand it. According to Helmut Hille, a German psychologist, this attribution mechanism processes instinctively (Hille, 2006). When we watch animated motion, the same attribution mechanism affects our



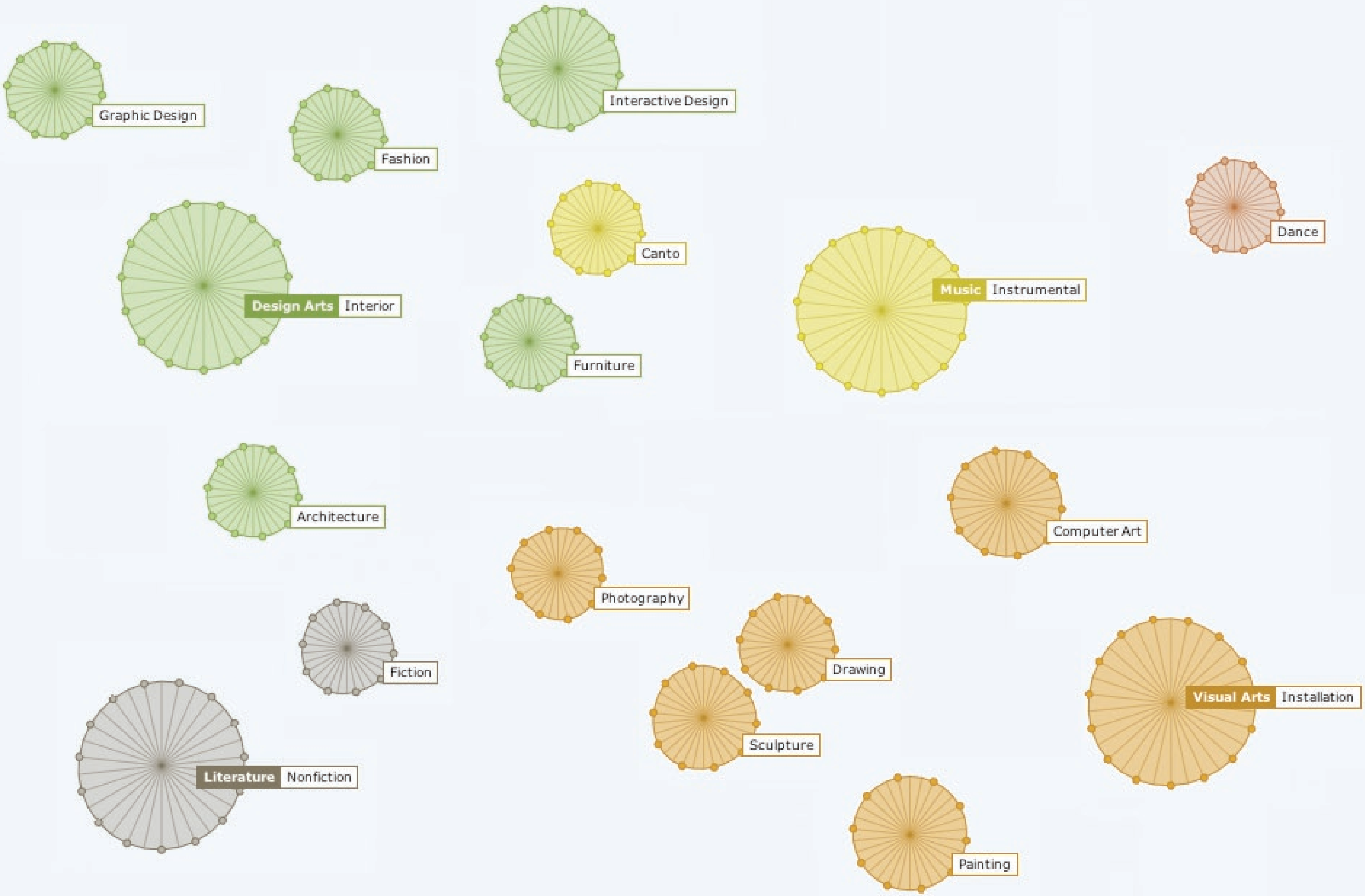


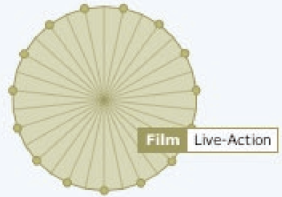
interpretation of motion. In the 1940s the psychologists Fritz Heider and Marianne Simmel made a cartoon animation in which a circle and two triangles move against and around each other and a diagram of a house. Test-persons made up a social plot in which, for instance one triangle was seen as an aggressor. This study has shown that the movements of simple shapes cause automatic animistic perceptions (Carnegie Mellon University, 2007). This study is closely connected to anthropomorphism, which involves a mental model in which the nonhuman like an animal or object is thought to have human attributes. For example, I may blame my computer for shutting down; think it intended to act as it did. “When we are interacting with an animal or object, we cannot think intellectually about what is really going on, for instance a computer program. Instead we focus on what the animal or object is doing and automatically make attributions as we do with other people” (Carnegie Mellon University, 2007).

CASE STUDY
JELLYFISH

AN ENCYCLOPEDIA OF THE ARTS

The case study was developed with the help of my advisor Prof. Brian Lucid and the technical support of Florian Jenett in the class Design Major in Spring 2005.
The assignment was to visualize an encyclopedia of the arts. *Jellyfish* is a visualization of its hierarchical and semantic structure. The visual and behavioral metaphor of a swarm of jellyfishes is used to represent, structure, interact and navigate through the encyclopedia.

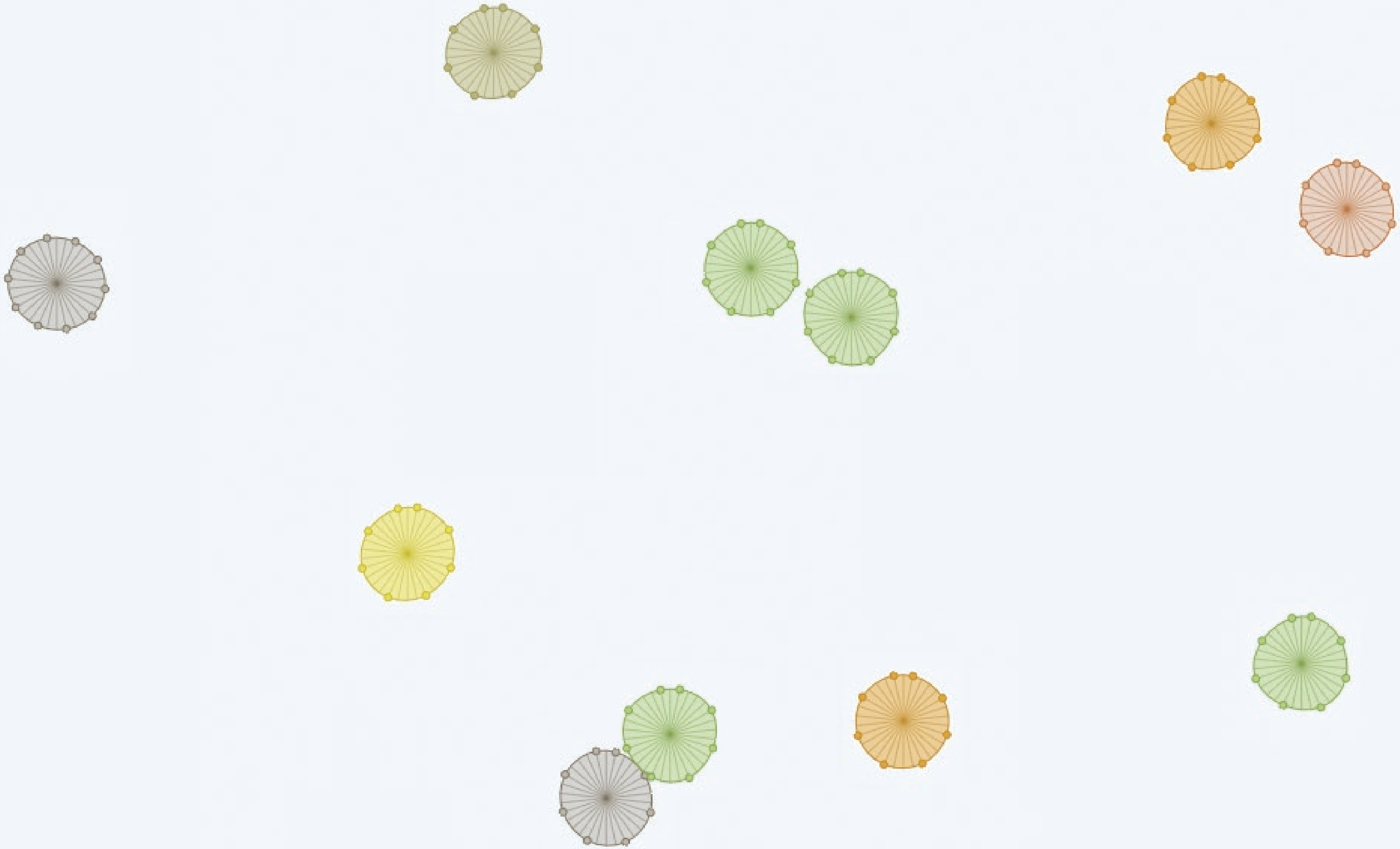

Graphic Design
Fashion
Interactive Design
Dance
Canto
Design Arts
Interior
Music
Instrumental
Furniture
Architecture
Computer Art
Photography
Fiction
Drawing
Visual Arts
Installation
Sculpture
Literature
Nonfiction
Painting

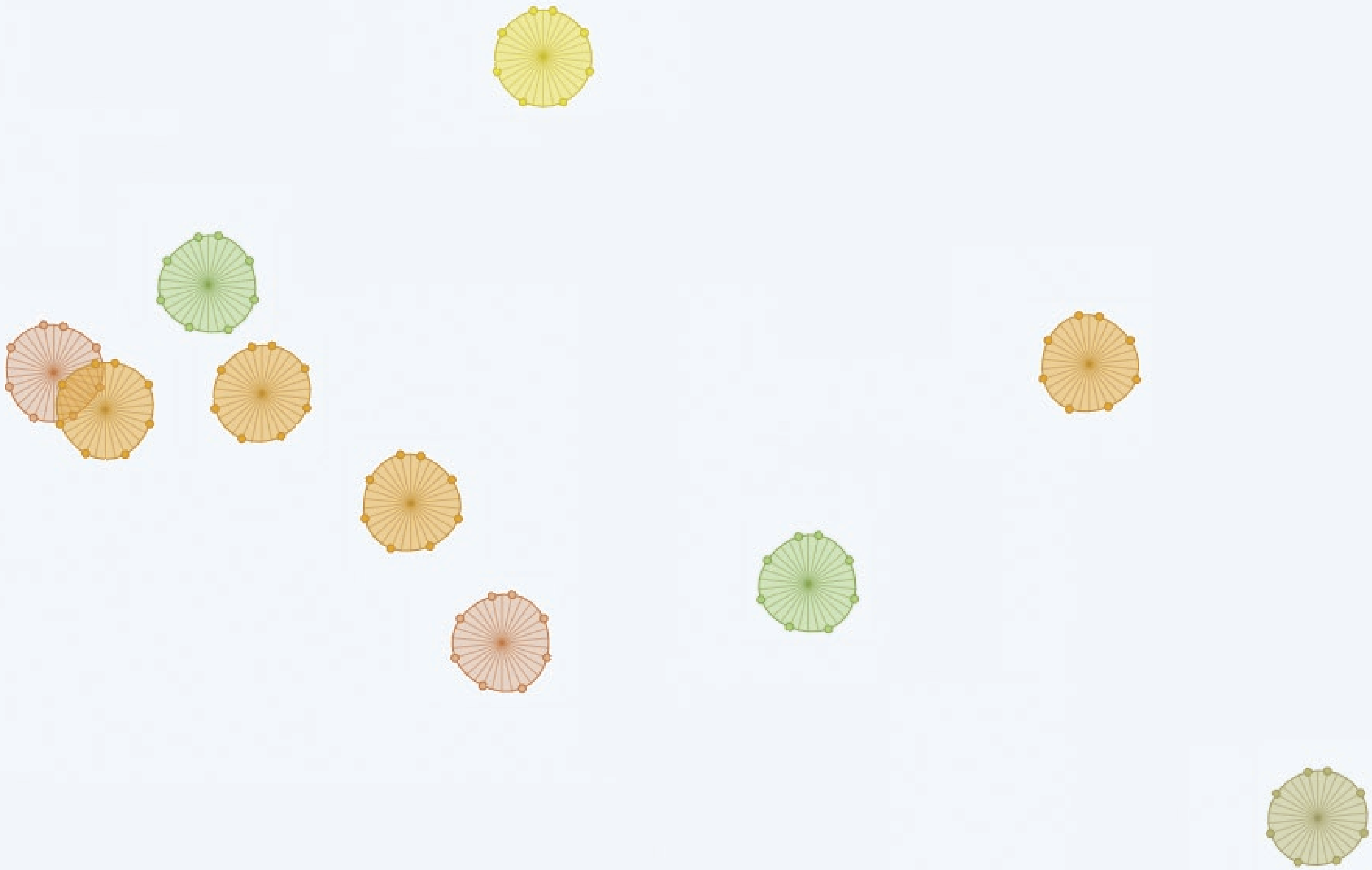


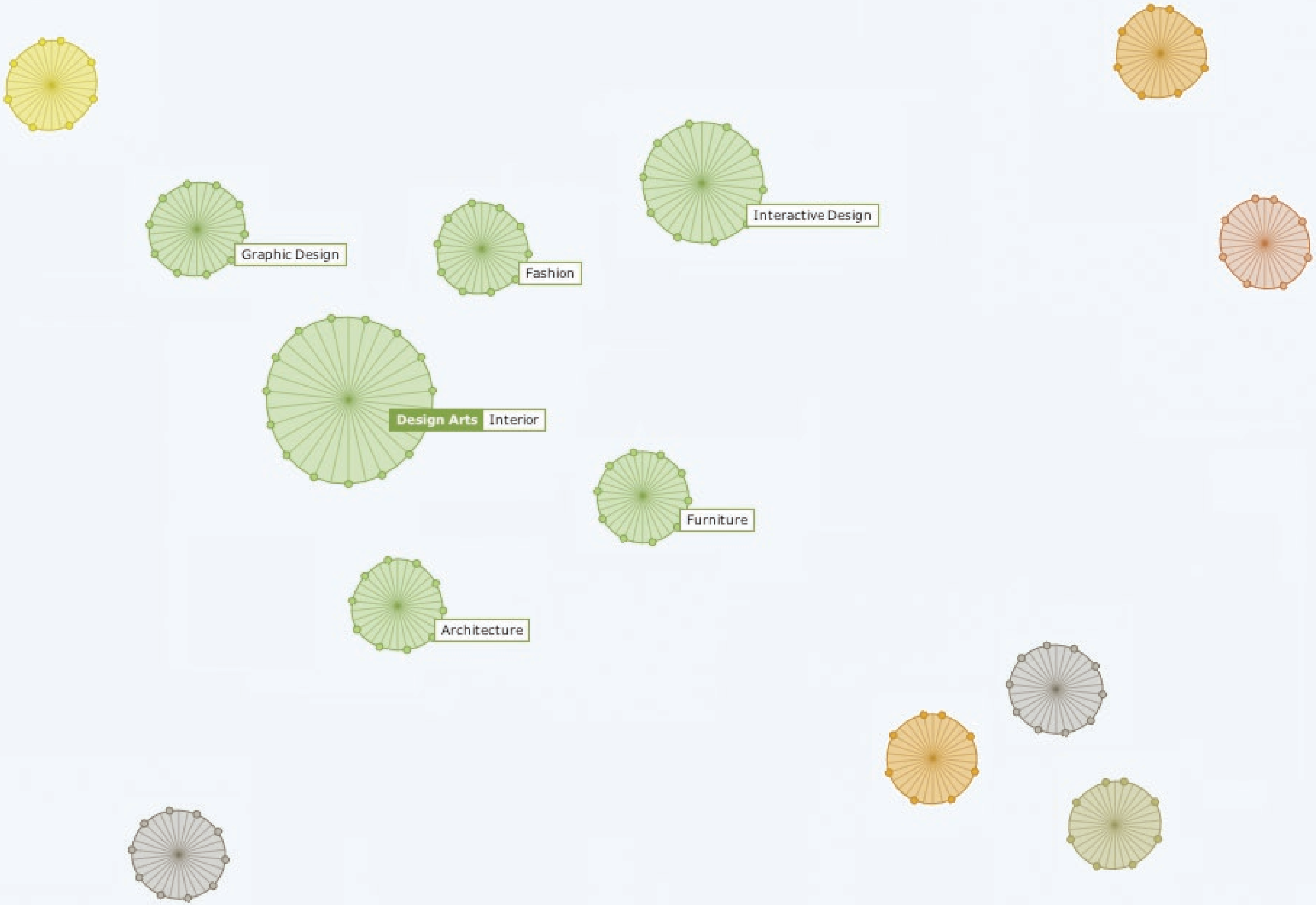
THE JELLYFISH FAMILIES

The encyclopedia of the arts is structured in six main categories: visual arts, design arts, performing arts, literature, film and music. Six color-coded jellyfish families represent these main categories. Each of these jellyfish families, respectively main categories, is comprised of several family members – the subcategories. One jellyfish represents one subcategory. For instance, the family design arts is composed of the green jellyfishes graphic design, interactive design, architecture, furniture, interior, fashion.

It would be interesting to offer more structures possibilities in addition to the arrangement by genre. For instance, *Jellyfish* could be structured by art movements, by media, by time, by origin country.



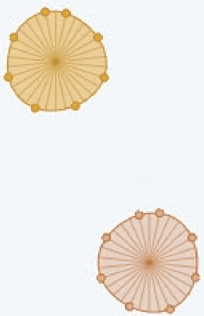


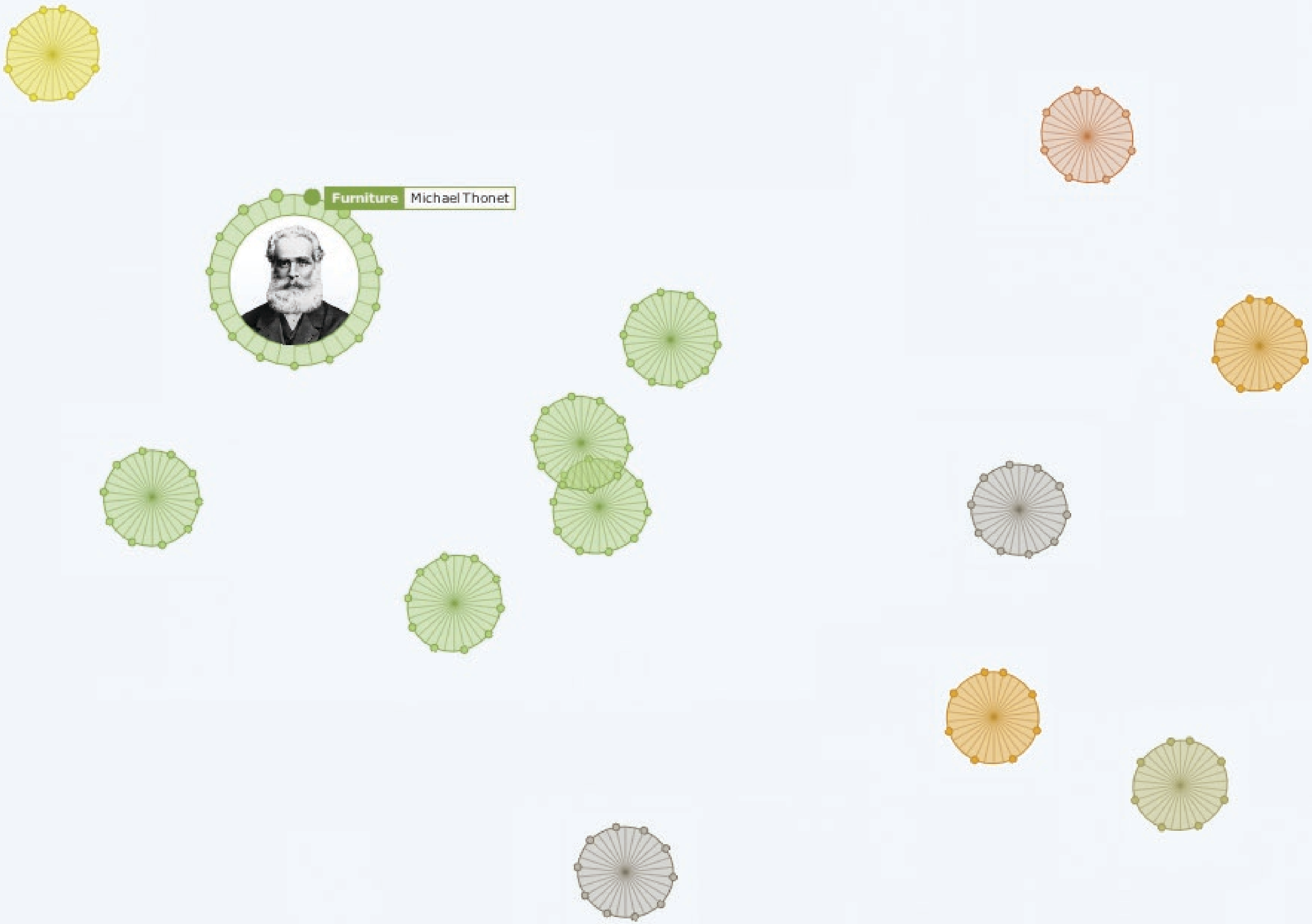

Graphic Design
Fashion
Interactive Design
Design Arts
Interior
Furniture
Architecture

JELLYFISH AND ITS GROUPING BEHAVIOR

All jellyfishes freely swim around while the application is running.
By touching one jellyfish, his relatives of the same main category swim next to him. For example, by touching the *furniture* jellyfish, the other jellyfishes of the design arts family swim next to it. Jellyfishes of the other families, move away from the chosen one and do not group.

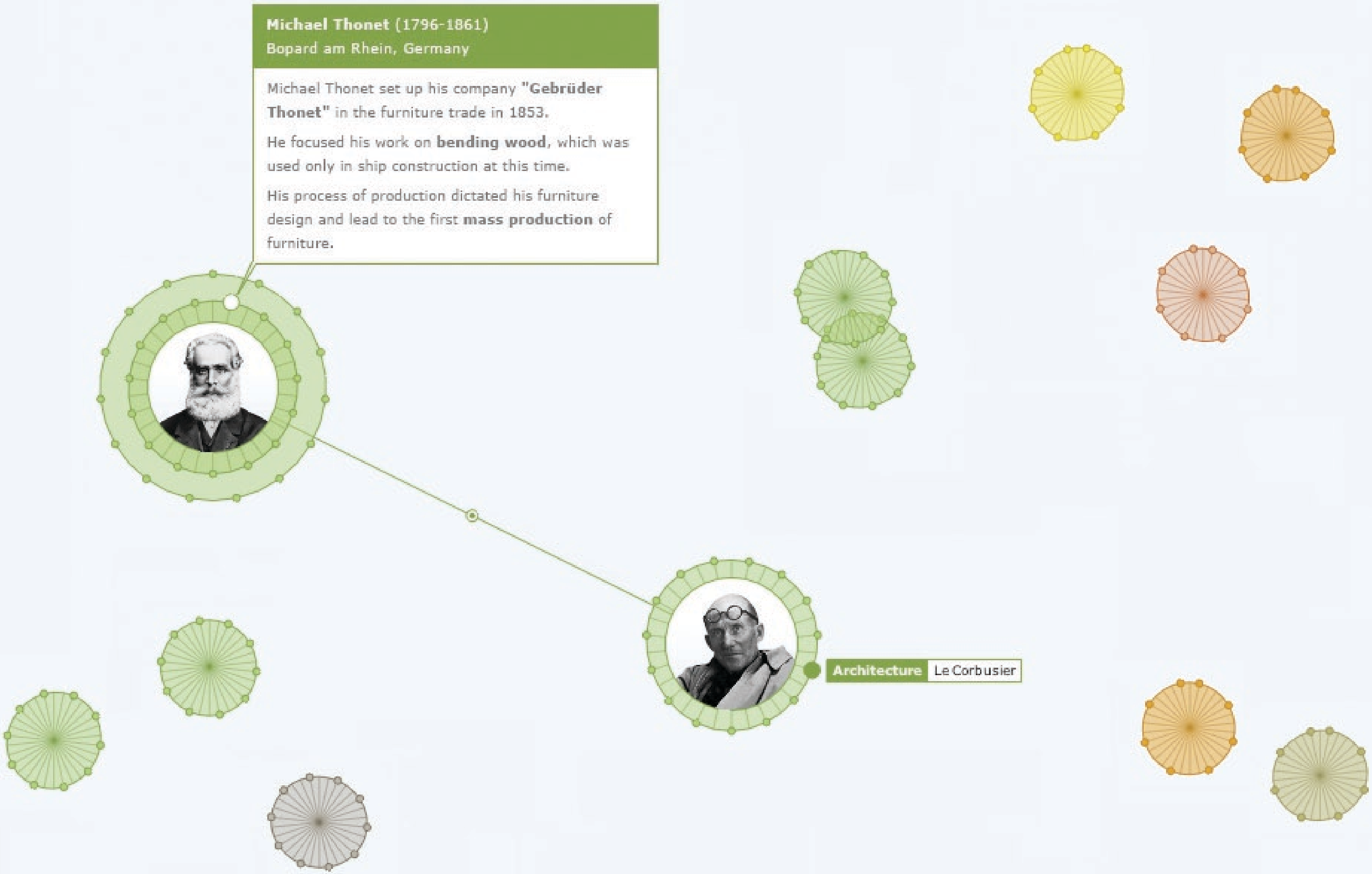
Therefore the grouping behavior of the jellyfish visualizes the structure of main categories. The motion of jellyfishes toward each other or away from each other structures the main categories. The user can understand this behavior because he can connect it easily to experiences he has made in the real world. This grouping behavior is a natural human sociological phenomenon, groups are drawn together because of similar interests of people or they avoid each other based on contrary interests. It is a natural behavior pattern. Things which belong together are moving to each other, they like each other. Things, which do not belong to them, avoid this proximity.



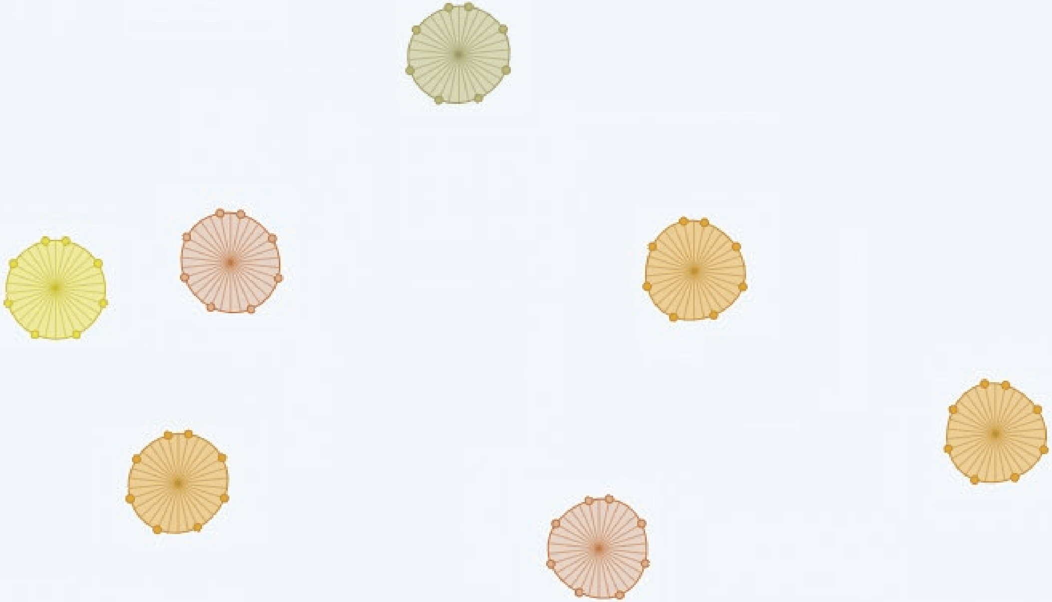

Furniture
Michael Thonet

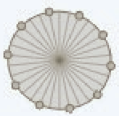
ROLLOVER AN ARTIST

On the border of a jellyfish the artists who have worked in this certain subcategory are represented as dots. By rolling over a dot the name and picture of a certain artist is shown. For example, the user can find the artists like Michael Thonet or Charles Eames inside the *furniture* jellyfish.



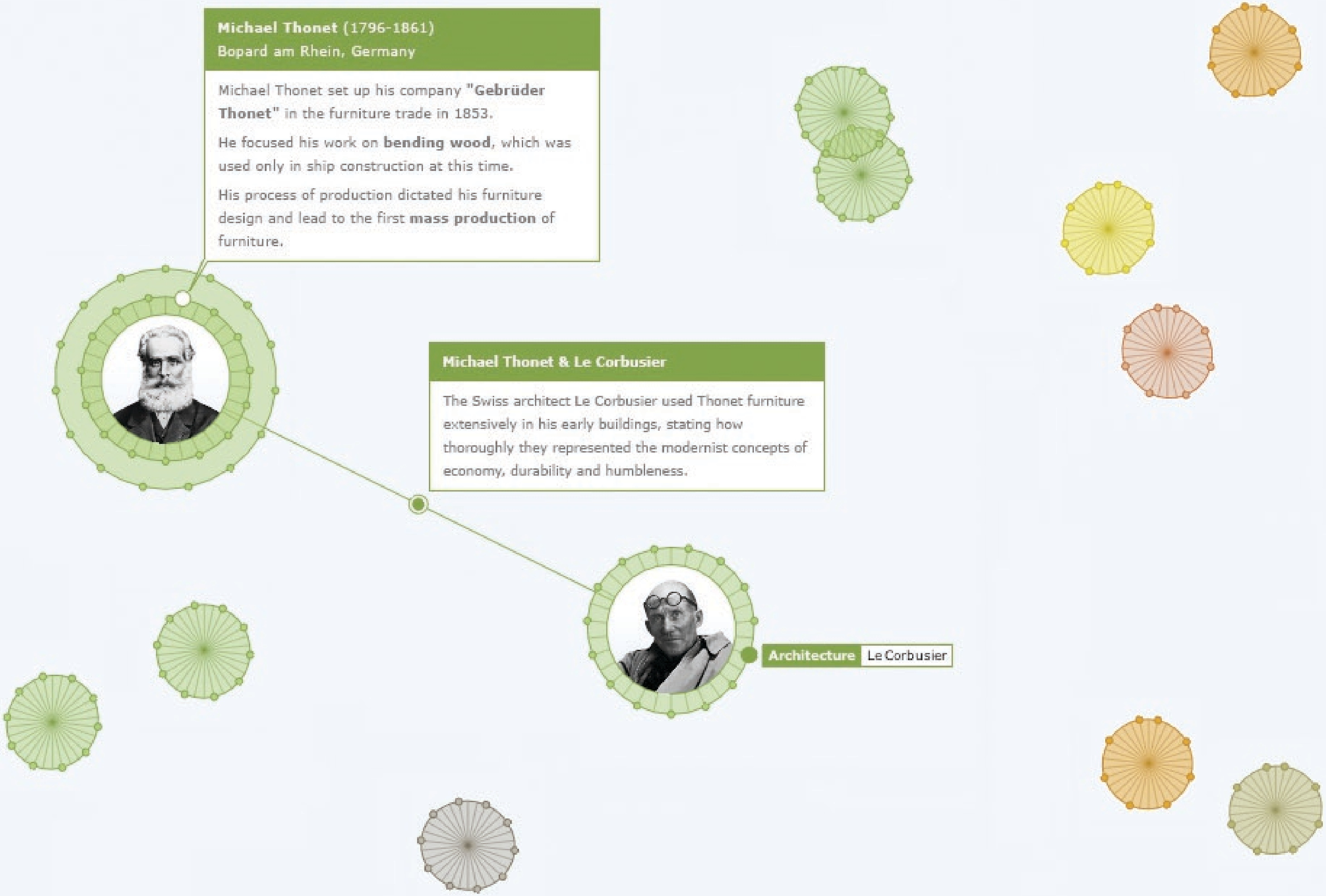
Michael Thonet (1796-1861)
Bopard am Rhein, Germany
Michael Thonet set up his company "Gebrüder Thonet" in the furniture trade in 1853.
He focused his work on bending wood, which was used only in ship construction at this time.
His process of production dictated his furniture design and lead to the first mass production of furniture.
Architecture
Le Corbusier

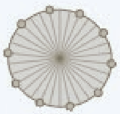




SELECTING AN ARTIST

Selecting one artist, for example Michael Thonet, triggers different things at once.
First, a second circle grows out of the jellyfish. The border of this second circle is where the artist's works are located. Dots are used again to represent the specific works. In addition a text field appears, containing information about the artist.

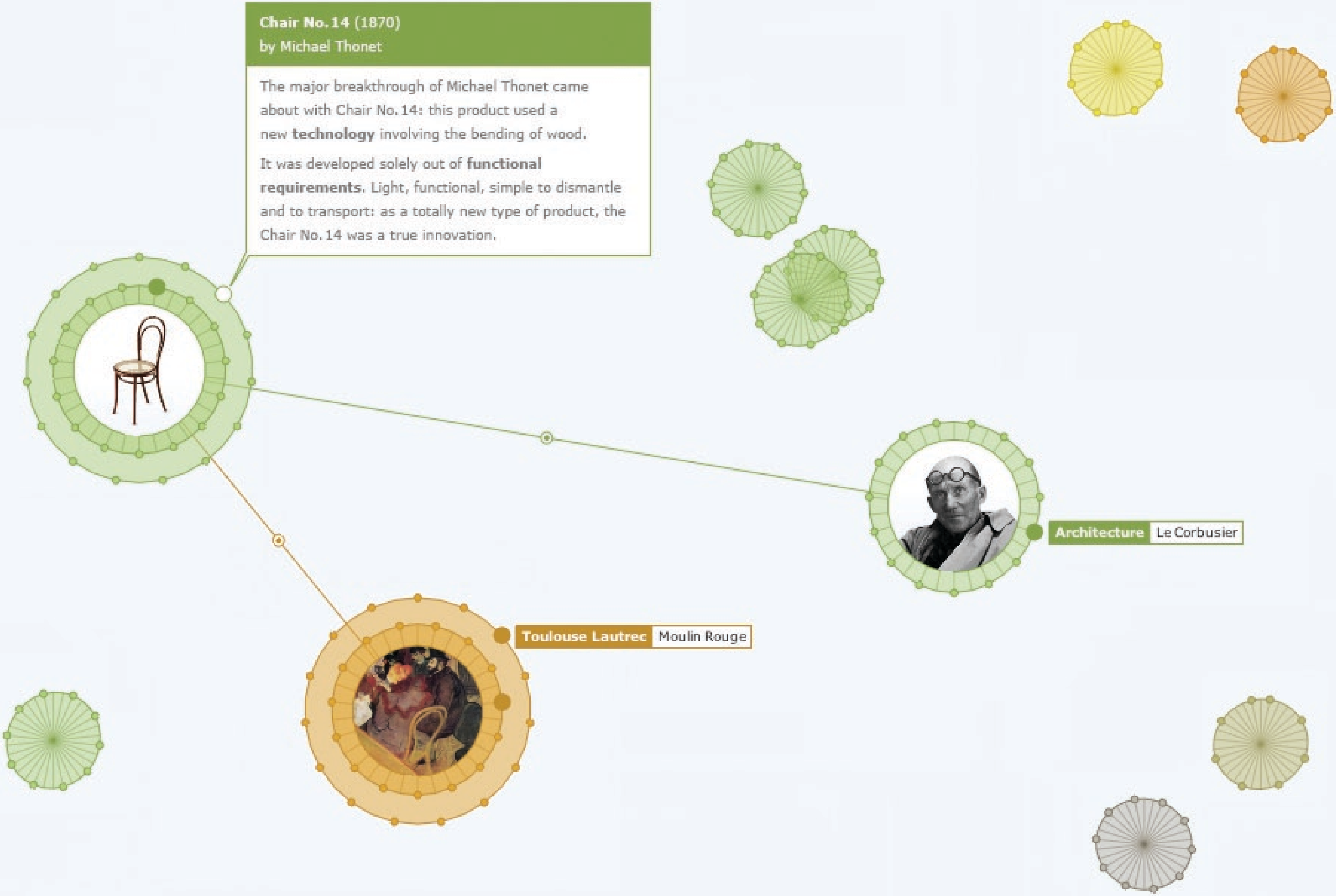

Michael Thonet (1796-1861)
Bopard am Rhein, Germany
Michael Thonet set up his company **"Gebrüder Thonet"** in the furniture trade in 1853.
He focused his work on **bending wood**, which was used only in ship construction at this time.
His process of production dictated his furniture design and lead to the first **mass production** of furniture.
Michael Thonet & Le Corbusier
The Swiss architect Le Corbusier used Thonet furniture extensively in his early buildings, stating how thoroughly they represented the modernist concepts of economy, durability and humbleness.
Architecture
Le Corbusier

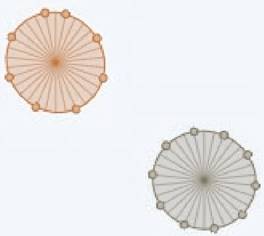


CONNECTION

By choosing an artist a connection to another artist becomes visible, which means that another jellyfish opens, showing a second artist. For example, by selecting Michael Thonet in the *furniture* jellyfish, the *architecture* jellyfish opens and shows Le Corbusier. Through the dot on the connection line between both jellyfishes the user can get information about the kind of this link. For example, the architect Le Corbusier used Thonet furniture extensively in his early buildings.

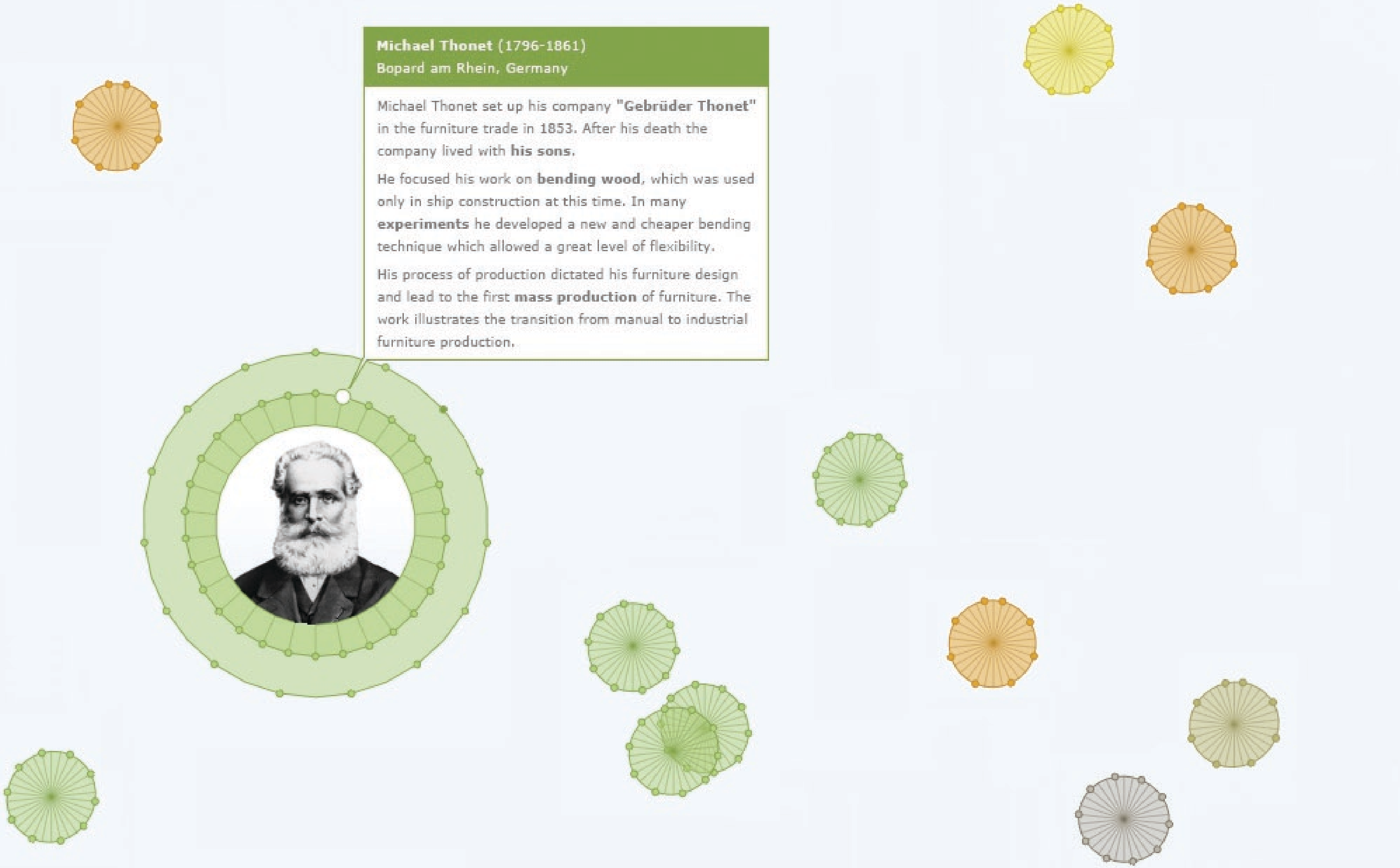
The visualization of these connections, like between artists from different disciplines, supports a better understanding of an encyclopedia of the arts. It dissolves partly the strict structure of categories and shows connections based on inspiration and impact of artists to each other.

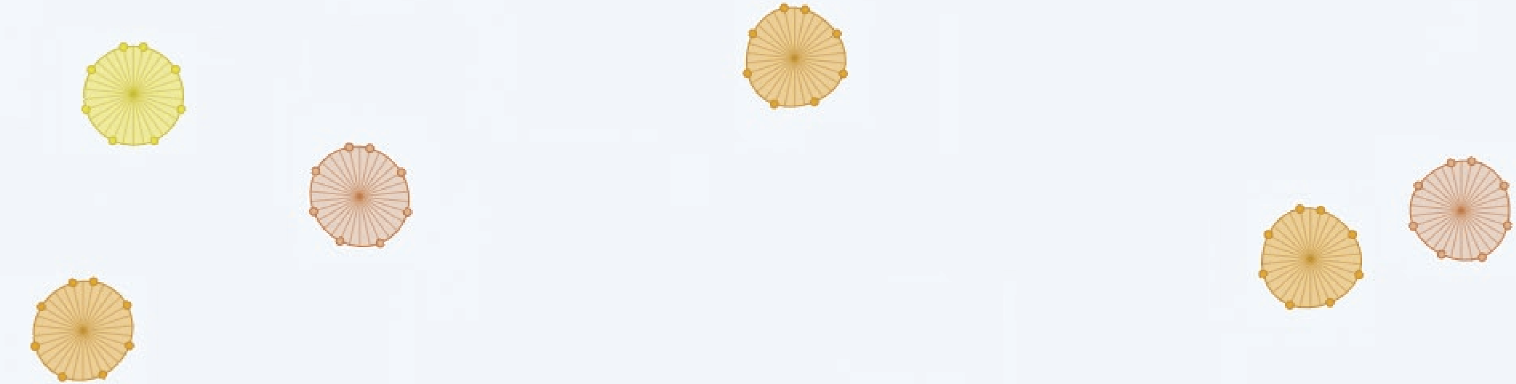

Chair No. 14 (1870)
by Michael Thonet
The major breakthrough of Michael Thonet came about with Chair No. 14: this product used a new technology involving the bending of wood.
It was developed solely out of functional requirements. Light, functional, simple to dismantle and to transport: as a totally new type of product, the Chair No. 14 was a true innovation.
Architecture
Le Corbusier
Toulouse Lautrec
Moulin Rouge

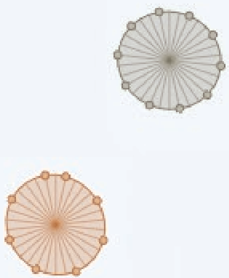


SELECTING AN ART WORK

After selecting an artist, the artist's works are shown on the second circle. By rolling over, a dot the name and picture of a certain artwork will be shown. For instance, the user can find "chair no.14" by Michael Thonet. By the same principle as choosing an artist, the user can investigate a certain artwork, too. This time two things happen at once. A text field containing information about the work and a connection to another art work appear. In the same way as before, the user can discover information about this link. For example, by selecting "chair no.14" by Thonet in the *furniture* jellyfish, the *painting* jellyfish from the *visual arts* family opens and shows "Moulin Rouge" by Toulouse Lautrec. In this painting Thonet's chair is shown.


Michael Thonet (1796-1861)
Bopard am Rhein, Germany
Michael Thonet set up his company **"Gebrüder Thonet"** in the furniture trade in 1853. After his death the company lived with **his sons**.
He focused his work on **bending wood**, which was used only in ship construction at this time. In many **experiments** he developed a new and cheaper bending technique which allowed a great level of flexibility.
His process of production dictated his furniture design and lead to the first **mass production** of furniture. The work illustrates the transition from manual to industrial furniture production.

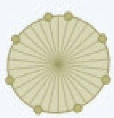




SCALING UP A JELLYFISH

The user can scale up jellyfishes. In addition to larger pictures, this offers a broader selection of artists – the number of dots on the jellyfish will be increased. Likewise the accompanying information text becomes longer and more comprehensive. Thereby the user can customize the amount of information to his needs.

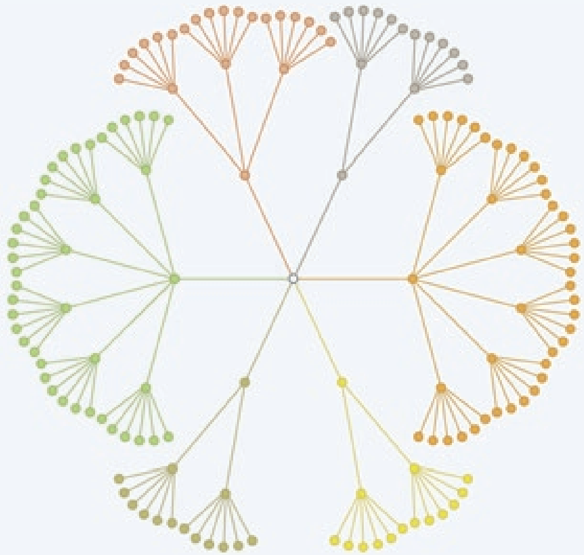
We can interpret the change in size of a subject differently. Growth can be a further development, an increase, or an upswing. Shrinking can be a decrease, a reduction, degrading, resolving, or a disappearing.
The change of size means more or less information and deep or deeper level of information. Maybe the change of a jellyfish's appearance could also involve a change in its behavior. Is the motion and behavior of a jellyfish slower and lazier when it becomes bigger and heavier? And how does it behave after an enlargement, after the user has seen its content? Is its behavior different after having briefly engaged with it? Is it insulted?

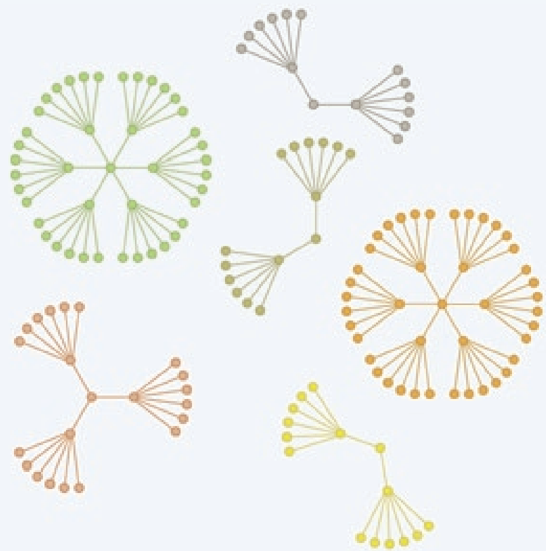


ABOUT JELLYFISH

I had the idea to use a hierarchical and semantic structure to visualize the encyclopedia of the arts and to use it as navigation through the system in the beginning. I wanted to experiment with how abolishing the separation between structure, navigation, and content can affect the user.

During presentation to and discussion with my class, the DMI faculty, and friends, I noticed that *Jellyfish* was almost immediately understandable. There was often no need for detailed explanation about navigation, interactivity, and certain behaviors. But the most interesting observation was that people wanted to interact with the system themselves. They did not want to watch it; they wanted to experience it. This suggested that this kind of system makes people curious to explore information, which is a requirement for greater understanding.



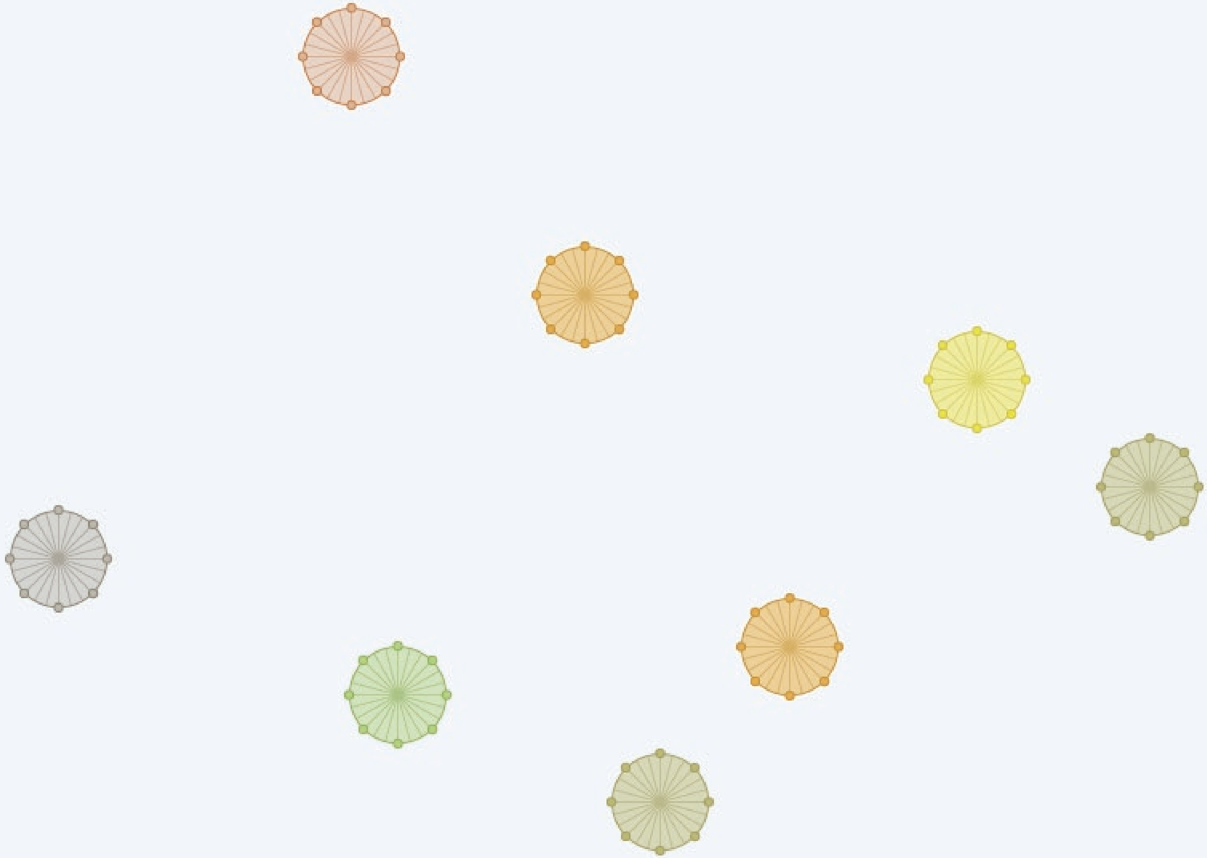


THE DEVELOPMENT

(1) In the beginning of this project I started to sketch the structure in form of one huge tree with parent elements (main categories) and child elements (subcategories, artists). This tree could visualize the hierarchy; but it was difficult for me to include the semantic connections between artists.

(2) Then I started to resolve the strict visual hierarchical structure and visualized main categories as several smaller trees. The idea was to use the motion of these trees to show semantic connection (motion and rotation towards or away from each other). But still, it seemed too complex.

(3) At the end, I resolved the main category trees into subcategory trees. The result was the abstracted form of a jellyfish – although I had not named it yet. When I presented my sketches in class, I noticed that I talked about these forms as if they were humans or animals. For instance, these subcategories group because they are family and like each other. It was easier for me to explain my developed system by describing motions of the forms as a behavior of animals or humans. It was less abstract. It also helped my classmates to understand and to correctly interpret the behavior of these information elements. After recognizing this, I searched for direct associations. Based on the form of the cycle and the little dots on its border, the metaphor for a jellyfish arose. In retrospective, structure, form and main behavior were created at first; the metaphor jellyfish was developed later. If I had structured the encyclopedia differently in the beginning, for instance structured by time, maybe I would not have developed a natural metaphor at all.



WHY JELLYFISH AND NOT SOMETHING ELSE

The metaphor jellyfish is appropriate to the encyclopedia project for several reasons. Jellyfishes are animals, which we can imagine could group in swarms. This behavioral characteristic was important, otherwise the grouping behavior of the subcategories would not be understandable. For instance, the metaphor of house cats could not work in this case. They are more loners; we see often only one cat or two together. We can also imagine that jellyfishes appear in smaller groups and not only in huge swarms. This was important because I only had twenty-one subcategories to represent. For instance, the metaphor of an ant could not work in this case. A usual ant colony consists of one million ants. It would be unusual to see only twenty-one ants the whole time. It was also important to use an animal and not a plant like a tree. Otherwise the motion and the behavior could not be understandable. I do not often see a tree leaving its position. Usually I do not connect an encyclopedia of the arts with jellyfishes. I relate symbols like paintbrushes or materials to the art world. But I have not used the metaphor jellyfish to visualize the figurative art world, I wanted to visualize the structure. Therefore the actual content of jellyfish like the artists and artwork can be replaced by any other content which can be structured similarly, for instance, the content of an e-commerce web site.

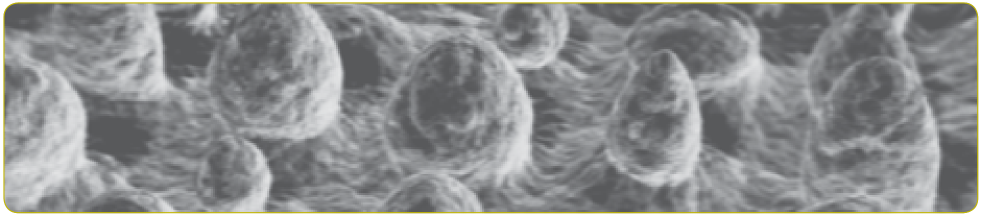
PERSONAL CONCLUSION

When I started this project, I had not had the idea of using a natural metaphor to visualize a data structure in my mind, especially not the metaphor of a jellyfish. I made *Jellyfish* before I started to define my thesis topic. But this project inspired me to continue my research in this field and to build my thesis upon it.
Other case studies like *Natural Icons*, *Pattern Cards* and *Anymails* have their origin in this project. *Jellyfish* made me curious to think about natural metaphors and how they can be used in also different ways, for instance to represent conditions of data. I also started to recognize motion as an active part of information mediation.

BIOMIMICRY

BIOMIMICRY

When I discuss my thesis, people often ask me if it is related to biomimicry. Biomimicry is a science, which looks for solutions to technical and human problems in biology. It is an intersection of different disciplines like botany, zoology, engineering, mathematics, computing. Decoding “inventions of nature” and their possible transferability and technical implementation is the main focus.
Janine Benyus describes in her book *Biomimicry – Innovation Inspired By Nature* (1997) why it is so interesting for humans to revert to nature: “The core idea is that nature, imaginative by necessity, has already solved many of the problems we are grappling with. Animals, plants, and microbes are the consummate engineers. They have found what works, what is appropriate, and most important, what lasts here on Earth. This is the real news of biomimicry: After 3.8 billion years of research and development, failures are fossils, and what surrounds us is the secret to survival” (Benyus, 1997).
Nature serves as a model for different areas of implementation such as the development of new materials, improved mechanisms, better organization principles, or behavior patterns.

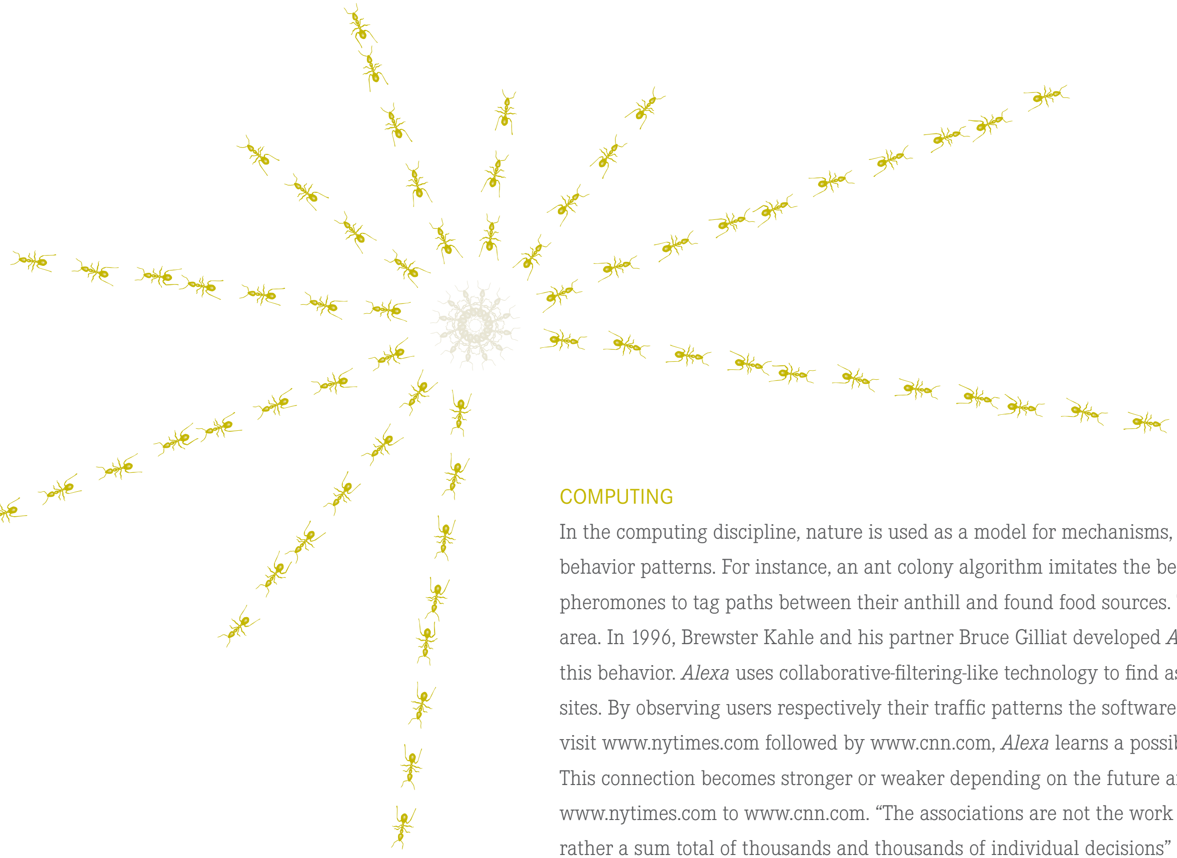


MATERIALS

In the research on materials, scientists develop new structures, methods, and functions that are based on nature models. The goal is to mimic biological material to use their special attributes.
An often cited example is the lotus effect. In the seventies leafs were analyzed to find out the connection between surface structures and plant species. As an incidental observation, scientists noticed that leafs with even surfaces are often dirtier than leafs with rough surfaces. This effect is obviously seen at the leaf surface of the lotus plant: the surface consists of tiny burls and wax crystals, which let water and dirt, roll off (Podbregar, 2002). Later this principle was transferred to artificial surfaces based on the biological model. In the meantime, first implementations are introduced onto the market, for instance self-cleaning tiles.

ARCHITECTURE

Nature has long been used as a model and source of inspiration for architecture.
Natural constructions like the skeletons of plants and animals are deemed as a shining example. Natural forms underlie the principle of efficiency and simplicity to achieve the best possible with minimal effort. Evolution forced them to save energy. Bionic construction design tries to transfer these worthwhile attributes to technical constructions. For instance, Frei Otto, a German architect, conceptualized the roof of the Munich Olympic stadium based on supporting tissue of plants and on the spider's web fixed between blades of grass. The glass and steel roof construction is hanged on masts, whereas the different warping of the roof-age provides improved strength.



COMPUTING

In the computing discipline, nature is used as a model for mechanisms, organization principles, and behavior patterns. For instance, an ant colony algorithm imitates the behavior of real ants, which lay out pheromones to tag paths between their anthill and found food sources. This behavior optimizes the search area. In 1996, Brewster Kahle and his partner Bruce Gilliat developed *Alexa*, software that is based on this behavior. *Alexa* uses collaborative-filtering-like technology to find associative connection between web sites. By observing users respectively their traffic patterns the software learns. If hundreds of users visit www.nytimes.com followed by www.cnn.com, *Alexa* learns a possible connection between both sites. This connection becomes stronger or weaker depending on the future amount of users jumping from www.nytimes.com to www.cnn.com. “The associations are not the work of an individual consciousness, but rather a sum total of thousands and thousands of individual decisions” (Johnson, 2001). Amazon uses this software to offer related links.

HOW IS MY THESIS RELATED TO BIOMIMICRY?

In my work, I investigate human perception and interpretation of natural form and behavior to structure and visualize information – not biology or biomimicry. In my case studies I do not analyze a jellyfish to imitate a biological mechanism, I investigate how we as humans perceive our environment to find metaphors from nature to utilize our interpretation ability. It is more a matter of identifying what non-human biologies can be said to parallel metaphorically existent human behavior. My thesis shares a greater connection to psychology and sociology than to biology and biomimicry.

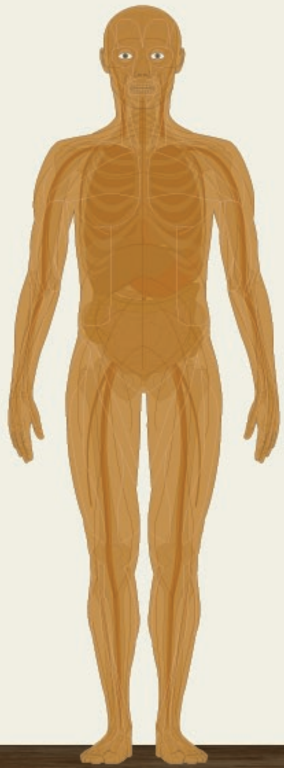
The organizational behavior of like information forming into groups, for example, is a natural human sociological phenomenon. In my case study *Jellyfish*, jellyfishes from the same family come together like social groups which are formed based on similar interests. This behavior is also a natural human cognitive phenomenon; within our field of perception, our minds tend to group like objects together. Just as our minds organize internally, we also organize externally; we put all our books on one bookshelf and all our socks in a drawer. And so metaphorically having similar information "swim" together is not a matter of "copying" or "mimicing" jellyfish, since this kind of behavior is already a strong natural human perceptual tendency. The shape and "swimming" behavior of the "jellyfish" is a metaphor, one that is in fact exhausted very quickly. I have no idea if jellyfish actually do swarm together if they carry similar information, and, as far as I know, jellyfish do not carry distinct sets of information within tiny circular peripheral nodes.

CASE STUDY
BODYMACHINE

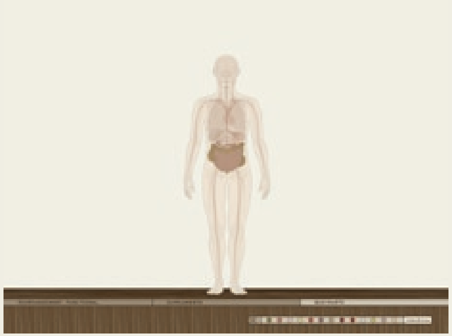
BODYMACHINE

The case study was developed with the help of my advisor Prof. Jan Kubasiewicz in the class Design Major in Fall 2004. The human body travels from place to place, yet it is also a place in itself – even a multitude of spaces. Within the place of the body, each subspace, or body part, is defined mainly by that part's function. For example, the eyes are located up high, to ensure a good view. The skin covers almost every part to protect our internal body organs from environmental influences. But what would a body look like whose parts were arranged according to other criteria?

I developed a prototype that lets the user interactively rearrange a human body by the weight of its body parts or by the percentage usage of our senses to perceive the world around us. Each arrangement leads to a new, strange looking figure: a creature. The project makes alternative views of the human body possible, by changing unsensational values like the weight of certain body parts into something interesting and accessible. I wanted to explore how the manipulation of a given natural structure (human body) can lead to other information. *Bodymachine* enables the user to compare and contrast information. I also tried to explore ways to integrate the user more in the process of visualization to achieve a richer experience. The user becomes Victor Frankenstein; he manipulates the human body.

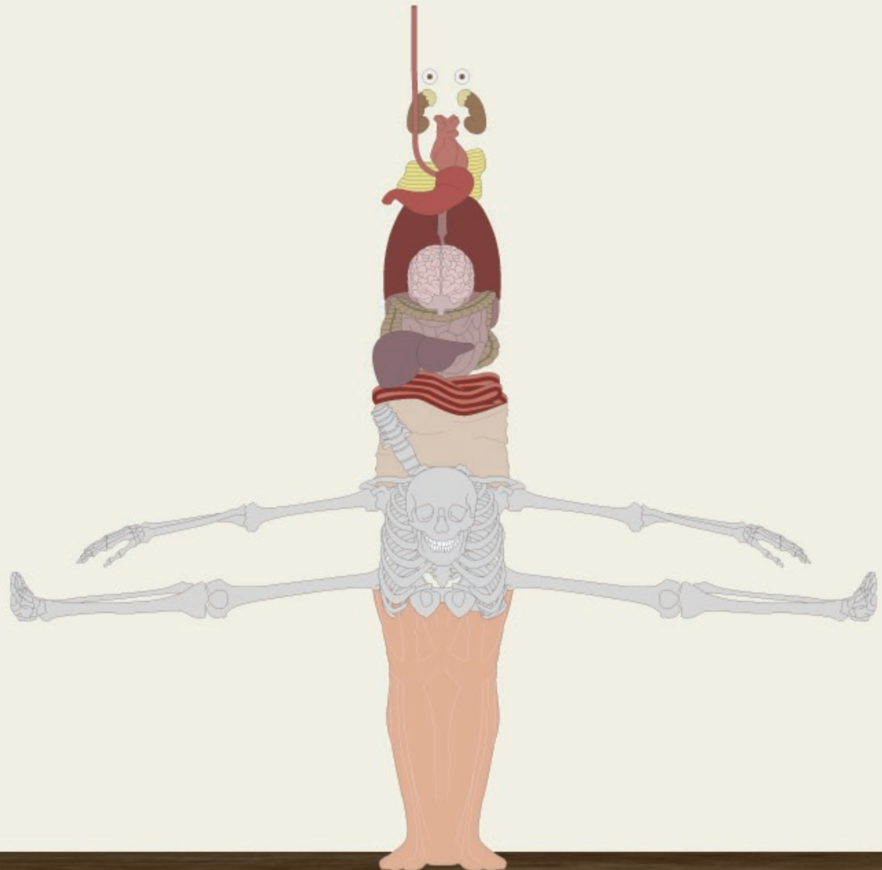


REARRANGEMENT: FUNCTIONAL | SUPPLEMENTS | BODYPARTS



IN THE BEGINNING

On the opening screen of my interface, the human body is displayed in its usual form – all body parts are placed correctly and the proportions of size are natural. The body parts are arranged by their function. The user can make certain body parts like lungs, liver, stomach visible or invisible by switching buttons on or off in the menu *Body Parts*. He can explore their size and location.



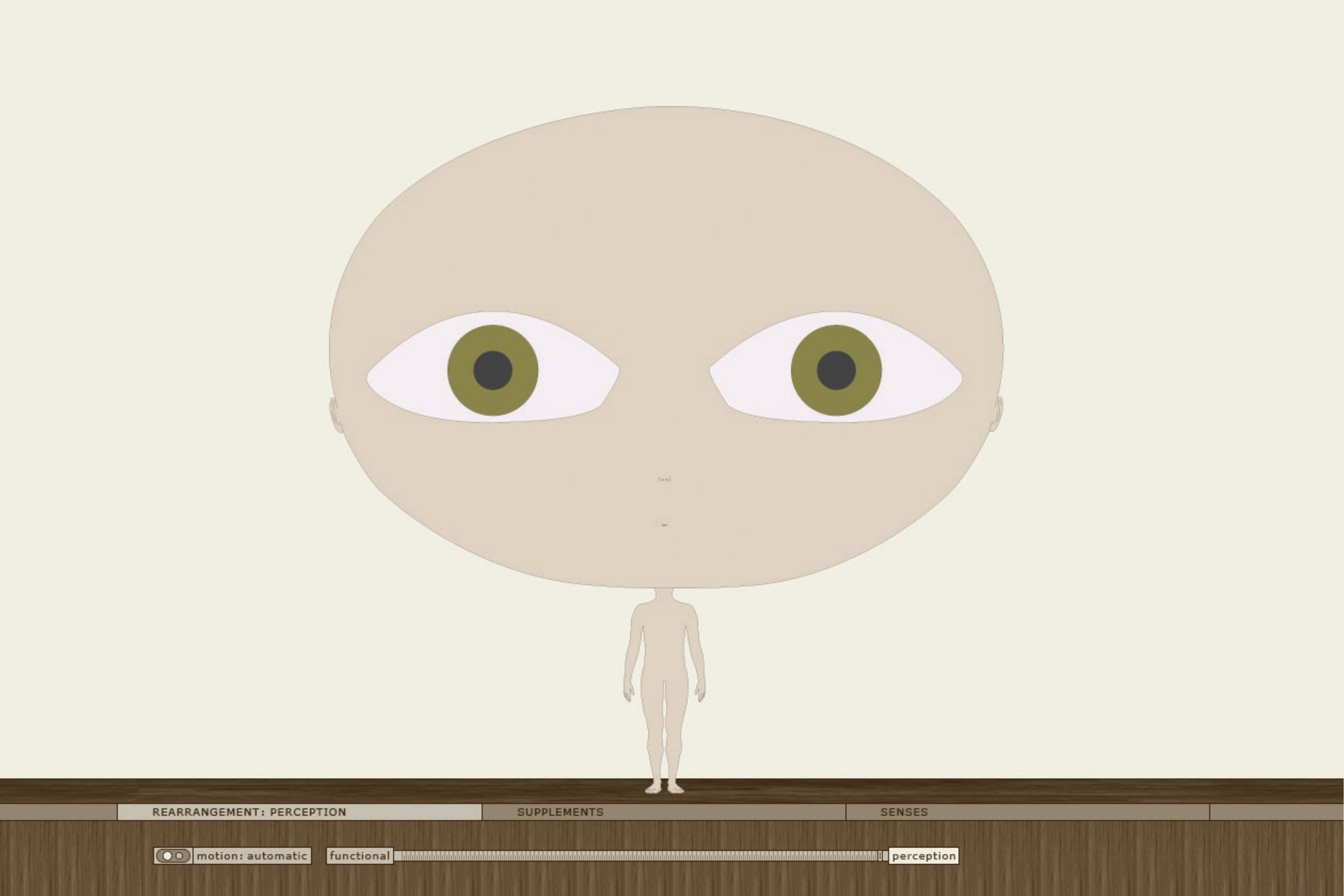
REARRANGEMENT: WEIGHT | SUPPLEMENTS | BODYPARTS

motion: automatic | functional | weight

REARRANGEMENT BY WEIGHT

In the menu *Rearrangement* the user can rearrange the human body by the weight of each body part. During the transformation, the body parts change their original location and move up or down depending on how heavy or light they are. The horizontal location of a body part indicates its weight in relation to the others. In this way the muscles, the heaviest part, are at the bottom, and the eyes, the lightest body part, are on top. The body parts are piled on top of each other depending on their weight.

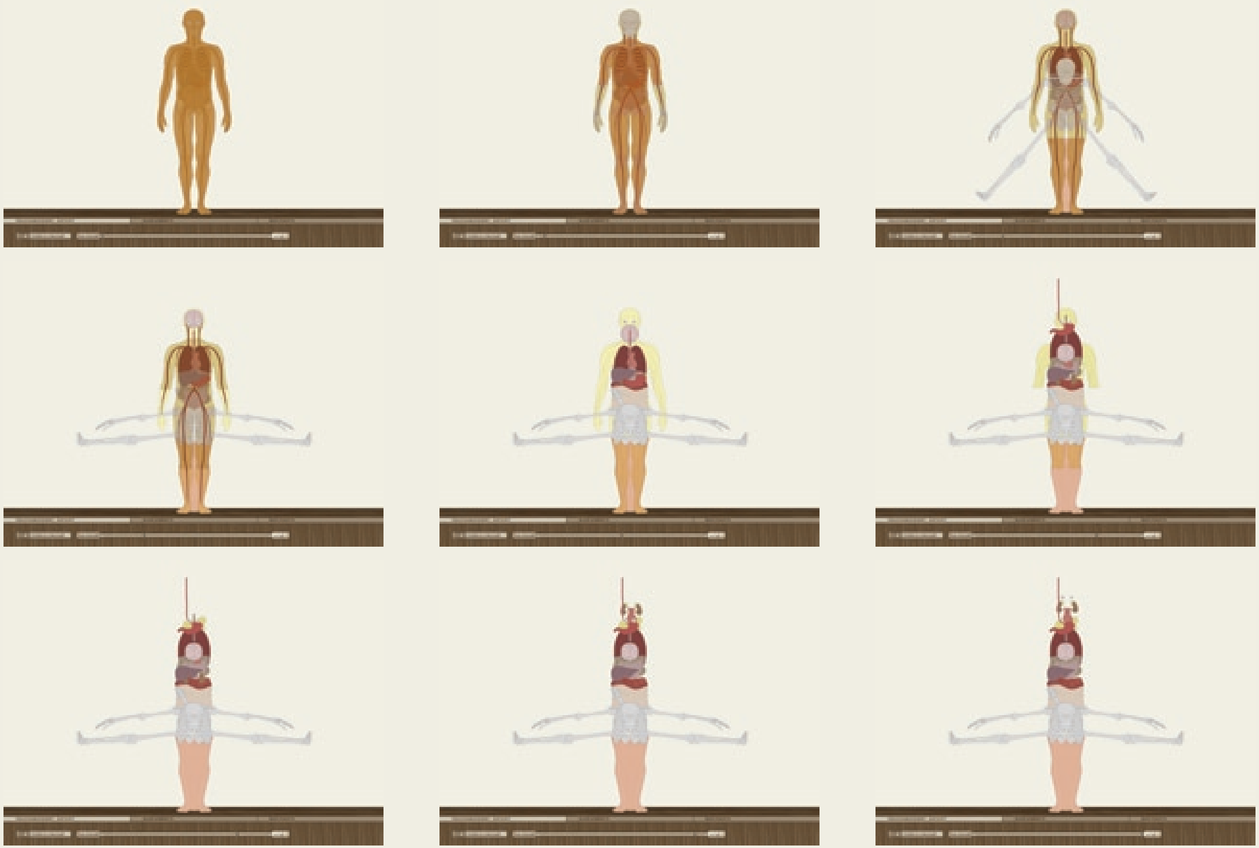
This visualization is based on a classic rule of information design – the placement of elements to indicate their hierarchical position. For instance, the placement of menu items on common web sites is used to differ between main navigation and sub navigation. In *Bodymachine* the placement of body parts is used to indicate their weight. In real life the weight of a part often influences its placement to ensure a stability of the whole. For example, when we arrange boxes in a pile, we try to put the heaviest ones at the bottom and the lightest on the top. We have learned this principle by success and failure. I arranged the body parts by the same principle to enable the user to connect this structure to real life experiences, to memorize this information.


REARRANGEMENT: PERCEPTION
SUPPLEMENTS
SENSES
motion: automatic
functional
perception

REARRANGEMENT BY PERCEPTION

The second arrangement is configured according to how frequently each body part is used to perceive the outside world. During this transformation, the body parts, which are connected to certain senses, change their size depending on how much they are used in relation to each other. In this way the eyes, representative of vision, become bigger because they are used 87% in perception. The mouth, representative of taste, becomes smaller because it is only used 1% of the time. The figure has very big eyes, small ears, small nose, and a very small mouth.

This visualization is based on a classic rule of information design – the size of elements to indicate their hierarchical position. For instance, the size of menu items on common web sites is used to differ between main navigation and sub navigation. In real life, we also interpret subjects based on their size. For example, I am more afraid of a bigger than smaller dog.

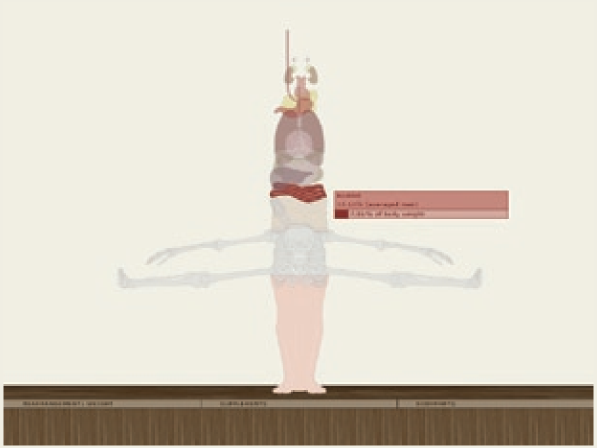


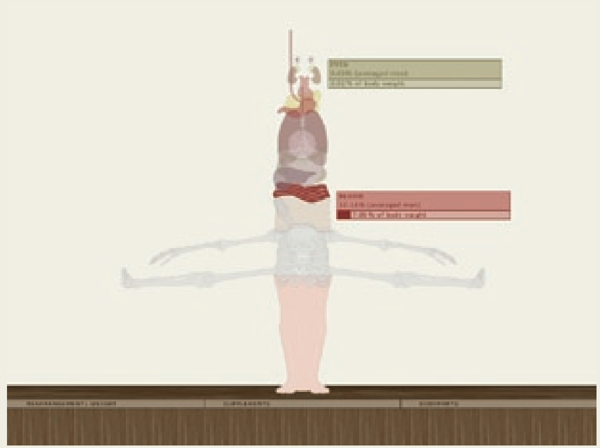
DURING TRANSFORMATION

An animation leads from one arrangement to another. For instance, during the transformation to *weight*, the user can observe how the brain, the eyes and the other body parts are moving downward to their new location. This process is part of the mediation of information and is important for the understanding of the result of a rearrangement. During the transformation *weight*, for instance, the user observes how the kidneys move upward as a countermove to the brain which moves downward. The horizontal location of a body part indicates its weight in relation to other parts. By watching these motions the user can understand that the kidneys are lighter than the brain.

The animation is structured; that means I use time to both structure and filter information. For example, during the transformation to the weight visualization, the heaviest body part moves to its new location first, the lightest one last. Consequently, although the user might not know what will happen next, he begins receiving information during the process of restructuring itself.

The user can choose if the transformation from one to another arrangement will be achieved automatically or manually. Through the automatic mode, the user becomes an observer of the event. By choosing manual control the user can use a slider to go through the transformation, and therefore has control over time.
He can go backward or forward, speed up or slow down the process of transformation.

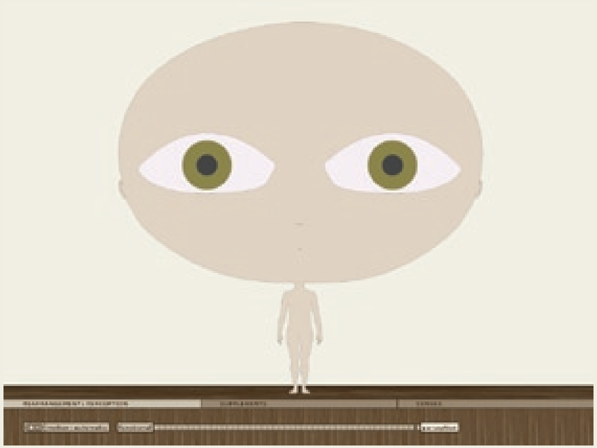


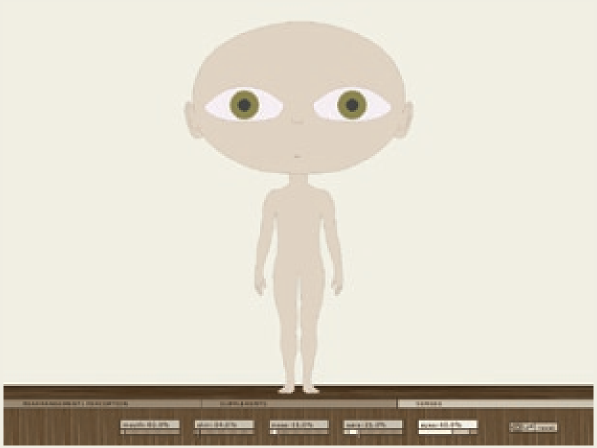


AFTER TRANSFORMATION

After each transformation, the user has the option to view the exact numbers of the rearrangement by rolling over certain body parts. In the menu *Supplements*, he can choose if and how information will be shown, for example, textual and/or audio form. In the textual form, bars visualize percent specifications.

Additionally, the information of a certain body part can be held and dragged, and by doing so gives the possibility for direct comparison. The connection between a pure visualization of information and exact numbers which are the framework of this composition is necessary for achieving a general view.





MANIPULATION

The visualizations are based on averaged data, such as the average weight of body parts. The user can manipulate these numbers and consequently can change the figure depending on his or her wishes or own body values.

For example in the rearrangement by perception, the user can lessen the percents of visual perception. By changing these numbers he is able to create his own customized creature.

ABOUT BODYMACHINE

CREATION OF GESTALT

The figures, *weight* and *perception*, are created out of statistical data, such as the average weight of body parts. By creating these figures, data become a gestalt, "an organized whole that is perceived as more than the sum of its parts" (Oxford English Dictionary, 2007). The user does not see data chunks; he perceives a gestalt, which expresses its structure (what are the individual body parts), context (which interrelation is between the individual parts), and meaning (what is the meaning of this structure and context) as a whole. According to Walter Dürr, gestalt is information in the context of information visualization (Dürr, 2004). Visualization is the creation of gestalts to enable the user to connect new information to already established knowledge. Using gestalt to mediate information is a common method in information design. Orientation systems, for example, use a variety of gestalt – like symbols for emergency exists.

TIME STRUCTURE

Rearranging the human body was my original idea. But during the process, I started to think more about how time could be used to structure information. Time and the use of time is important, not only because it is one element of interactive media. When is which information visible? Is it visible in the beginning or at the end of visualization? When is which information more detailed? When is which connection to another information visible? When is the time to compare information? When is information interactively mediated and when is it not? When can information be manipulated? When is information needed and when is it not?

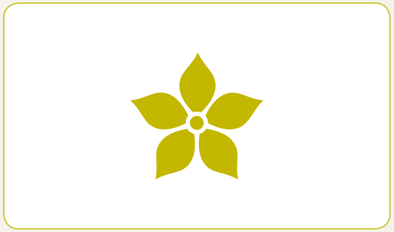
The development of a visualization can be compared to writing a screenplay with a classic narrative structure of a beginning, climax and resolution. In the beginning of *Bodymachine* I needed to create curiosity, to arouse the user's interest. Curiosity can be aroused by showing a little information, which the user can easily connect to his own experiences. Then the information flow stops. The user does not know how the rest of the information could also be connected to him.

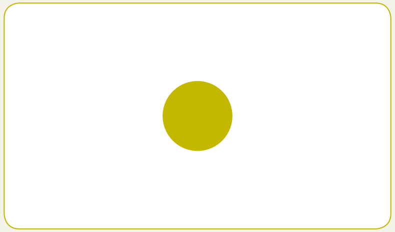
He wants to know more, he wants to know how everything will end, he wants to know the solution. Therefore it is important not to show certain information immediately, but to make them slowly step-by-step visible and accessible. For instance, while watching the rearrangement from one figure to another the user does not know how it will look in the end. At first the user is passively observing a process and then as a kind of climax he has the chance to interactively explore the object. By exploring the figure, rolling over certain body parts, he gets to know the core information on which the whole rearrangement is based. Here he receives detailed information, for instance the precise weight of a body part. Manipulation of information is somehow the resolution. The user already has got all information and is now able to change it depending on his wishes. He can create new figures, which make new interpretations possible.

IN RETROSPECTIVE ...

I would develop certain parts of the project differently.
For instance, the user should have more control over which data is used to create these figures. Right now, the figures are based on average data of a middle-aged man. The user should have the possibility to customize the information more to his own body, like to change the gender, age, size, etc. As a result the user could identify himself with the mediated information even more and, therefore, would be able to understand his own body better.
There should also be comparisons to other data. The user can understand, for instance, that the lungs are heavier than the kidneys, but he still does not know what 2.34 lb or 0.35 lb really means. Have our lungs the same weight as two sugar parcels? What has the same weight as our heart? The comparison to other subjects with which we deal in daily life could help to understand abstract data, like 2.34 lb or 0.35 lb.

COMMON VISUALIZATION METHODS





Pictorial Representation
It has a strong visual relationship to a real subject (photographs, 3d-models, drawings, illustrations, ...).

Graphic Representation
It abstracts and simplifies. It has a less representational relationship to a real subject (icons, pictograms, ...).

Abstract-Graphical Pictures
It has no recognizable visual relationship to a real subject (geometric forms, letters, ...).

VISUAL FORMS

A visualization is the whole system, which is created to mediate information. For instance, *Jellyfish* and *Anymails* are visualizations. Integral parts of these systems are visual forms, which represent information, its attributes and conditions (like the animals in my final project, *Anymails*).
Attributes and conditions help us to organize, to compare, and to evaluate information. These attributes comply with the classic structure principles. According to Richard Saul Wurman, a writer and information architect, you can organize everything by location, alphabet, time, category, and hierarchy (LATCH).
The visual form represents one or more of these attributes depending on which information should be visualized. Visual labels represent information attributes. It is a visual code: a certain attribute of information equals a certain visual label of form. Color, transparency, form, size, amount, position are often used to create this code. In general three kinds of visual representation are distinguished depending on their visual relationship to a real subject.: pictorial representation, graphic representation, and abstract-graphical picture.

VISUAL STRUCTURES

Structure defines the way data is arranged and how data can be connected to each other. Structuring is the first step to transforming data into information. How data is arranged affects how information will be interpreted. We create mental models to structure our thinking process. External models, like visualized information structures, support our cognitive ability to create these mental models. “Mental Models are representations of systems and environments derived from experience. People understand systems and environments, and interact with them, by comparing the outcomes of their mental models with real-world systems and environments” (Lidwell, Holden, and Butler, 2003). A structure filters information by certain attributes (LATCH). For instance, cities are organized by location on a map, names by alphabet in a telephone book, departures by time on a bus schedule, web site content by category, search results by hierarchy. Data is often structured multiple; more than two attributes are visualized at the same time. Multiple structures can show multiple interrelations between attributes. The user can uncover unknown trends and patterns. He can recognize which variable influences another one. He can understand causes and effects. In Minard’s visualization, for example, a viewer can recognize the close relationship between the human victims and environmental conditions such as temperature (see *Introduction*).

Designers often visualize a structure by placing information representatives like icons into a spacial and temporal system. How, where and when they are placed depends on certain attributes, which are connected to these representatives, like age or hierarchical rank.

Spacial Positioning

The common systems for positioning information are coordinate systems, and tree, nest, and stair maps. In coordinate systems, information representatives are placed at a certain x, y, z position according to their attributes. For instance, icons are arranged on a time line to show the temporal development of a subject. Tree, nest and stair maps are often used to visualize hierarchic directory structures, like the content of a web site.
The conceptual background of these systems is a topographic metaphor. For instance, documents are arranged in space that their distance to each other is conform to their similarity. Semantic proximity is visualized by spacial proximity.

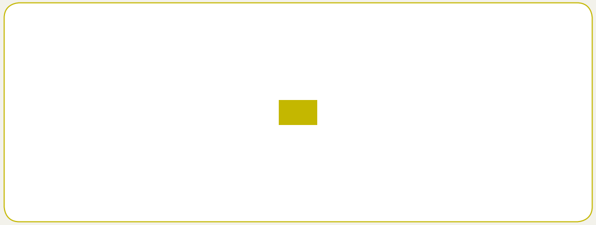
Temporal Positioning

"When" information is as important as "where" and "in which form" information. Time is an essential method to visualize information. We often deal with constantly changing data structures.
Designers use time to visualize this dynamic nature of information. Time can visualize the existence or nonexistence of information (if) and the duration of validity (when). Temporal clusters (temporal proximity) and temporal patterns (sequence) can be shown. The user can uncover temporal interrelations between information and dependencies on each other. A spacial temporal coordinate system offers to set a spacial condition of information into a temporal context: what, where, when. It is possible to visualize information through change of position, change of size, sequence of change (how often, how fast). The results are visualized patterns in change.

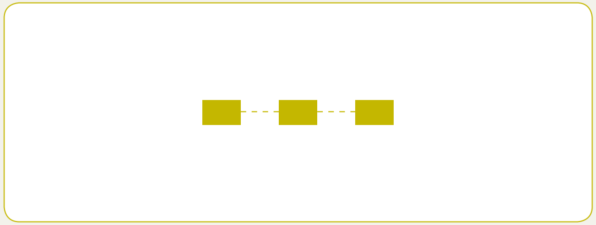
NAVIGATION

Navigation provides users with a way to move through a content structure – to move one point to another. Navigation has the following functions: it gives us an overview of offered information – where can we find what; it helps us to orientate ourselves – where are we, where were we before, where can we go; and it shows us how we can use a system – how we can find information.

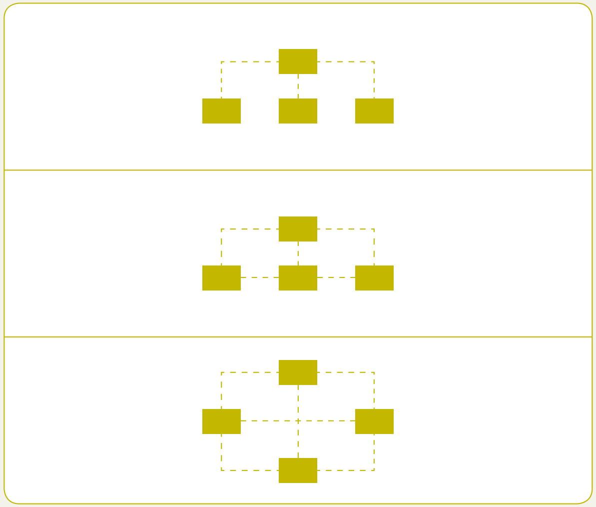
There are different types of navigation, which define the user's possibility to move through the structure: automatic navigation, predetermined navigation, and user determined navigation.



Automatic Navigation
Automatic navigation occurs when information is presented by the system without a user's input. An example is a linear, uncontrollable, animation.



Predetermined Navigation
Predetermined navigation occurs when the user has only one choice of where to go next, but can choose when he wants to go. The possibilities are: go next or go back.



User Determined Navigation

User determined navigation occurs when the user can choose which content to go next from a number of options. There are three different forms of user determined navigation:

Tree

go next, go back, go one layer up, go one layer down

Network

go next, go back, go one layer up, go one layer down,
go to information which is located at a different branch

Single Frame Structure

go in all directions

INTERACTIVITY

According to Prof. Dr. Rolf Schulmeister, professor for e-learning and multimedia at the University of Hamburg (Germany), interactivity can be differed in six levels (Schulmeister, 2002).

1. Watching a Subject The user can watch information without any control, like a picture or movie. There is no interactivity.

2. Control of Process The user can select objects to make information visible or invisible. It is pure control interactivity, like “play”, “stop”, and “rewind” which is offered in animations and movies.

3. Change of Display The user can manipulate the display of information, like scaling, zooming, rotating a subject. For instance, he can reduce or enlarge the body of information.

4. Modifying Information The user can rearrange information within certain parameters (filters). For instance, he can restructure information by time or categories

5. Constructing Information The user can use offered cognitive tools to create information. For instance, he can create his own filters to rearrange information; he can manipulate and change data.

6. Intelligent Feedback The system is changing based on user’s behavior. The user gets intelligent feedback on his behavior.

Interactivity allows the user to participate in the creation of information; he can become a co-creator. This is not only entertaining. The user can have a meaningful experience through which he can understand and memorize information. Information mediation becomes a process; the user has to do something to achieve information. “Tools of creation are extremely important components of a meaningful, compelling, and useful experience. Creative products require users to participate in shaping the experience or manipulating components instead of merely watching and consuming what the product brings forth” (Shedroff, 2000).
You can compare it to driving a car. You cannot learn and understand driving by watching. You learn by driving yourself. Watching information does not lead to understanding, but interacting with information can. Feedback, the consequence of your behavior, helps you to achieve a deeper understanding of information.
Interactivity can filter information in any number of ways. It offers a way to customize information to a user’s interest. For example, a user searches for information from a certain point of time. Filters can offer a way to quickly find desired information. Filters can customize information to a user’s standard of knowledge. For example, one user is bored about summarized surface information and wants to know more details, another one needs the surface information because he has not any previous knowledge. Filters can also customize information to a user’s perception ability. For instance, one user can deal with large body of information, another not. One prefers to listen to information, another prefers to watch or read information. Filters can offer information mediated more perceptible for the user.

CASE STUDY

THE LAB

THE LAB

The case study was developed with the help of my advisor Prof. Brian Lucid in Fall 2006.
I wanted to create a lab in which I can experiment with forms and motion to represent information. How can form indicate the age of information? How does something new or old look like? How can motion indicate personal relevance of information? How does big or small information move?

PRINCIPLE OF APPEARANCE
COMPLEXITY OF FORM
AGE
simple
complex
new
old
PRINCIPLE OF APPEARANCE
SYMMETRY OF FORM
POPULARITY
asymmetric
symmetric
low
high
PRINCIPLE OF MOTION
PULSATION
PERSONAL RELEVANCE
slow
fast
low
high
PRINCIPLE OF MOTION
SMOOTHNESS OF MOTION
ATTENTION
smooth
zigzag
low
high
PRINCIPLE OF MOTION
RADIUS OF MOTION
FEEDBACK
big
small
low
high
PRINCIPLE OF APPEARANCE
SIZE
PRINCIPLE OF MOTION
VELOCITY
SIZE
small
big
fast
slow
PATH OF MOTION
MATRIX OF APPEARANCE

AGE When was this information available?
For instance, when have I received an email?

POPULARITY How often is the same information used?
For instance, how many people visit a web site?

PERSONAL RELEVANCE How important is the information?
For instance, which email is more or less important?

ATTENTION Have I chosen this information before?
For instance, have I read an email yet?

FEEDBACK Have I responded to this information?
For instance, have I responded an email?

SIZE How big is the information?
For instance, how long is an email?

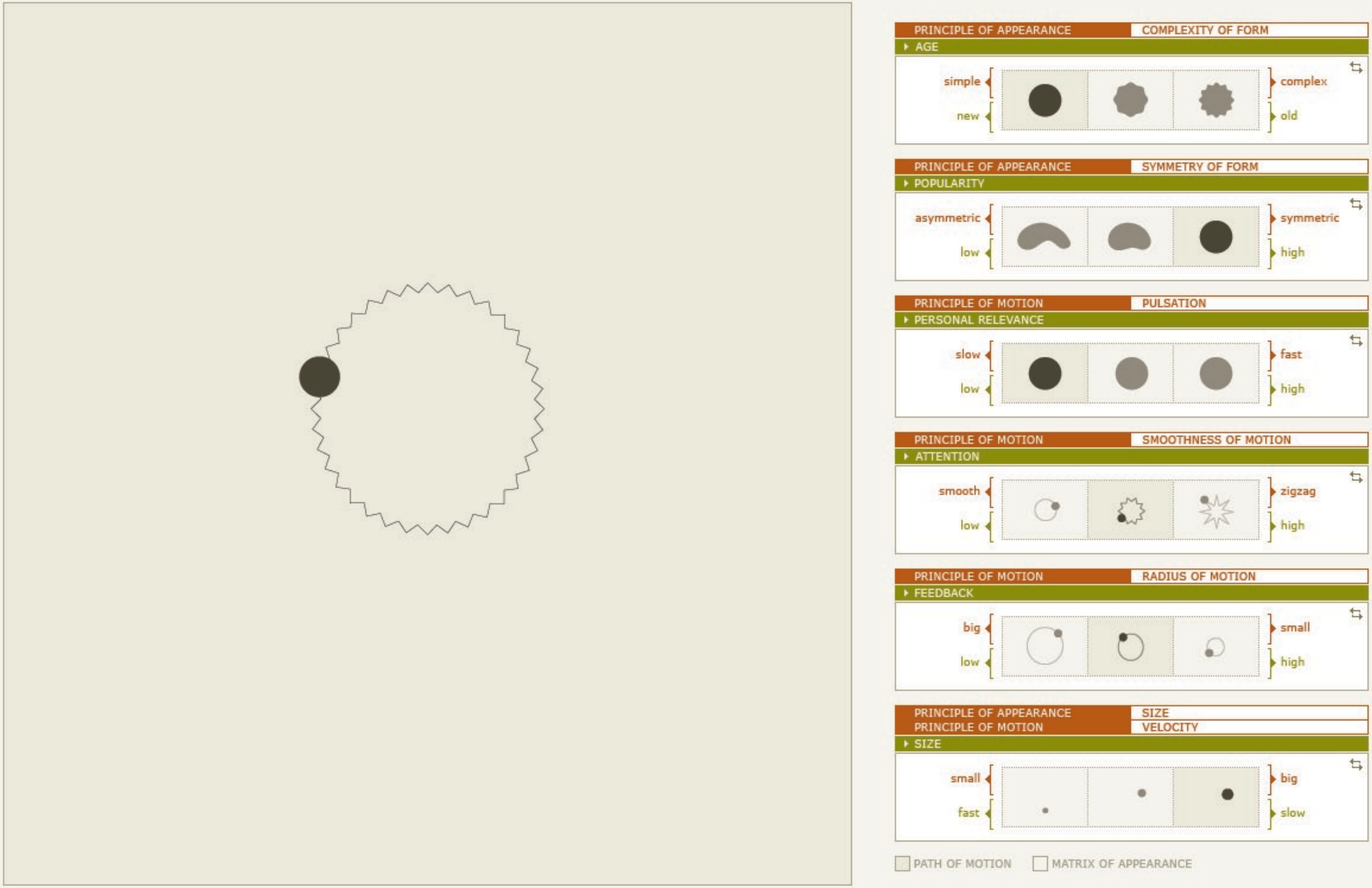
ATTRIBUTES

I defined six different information attributes which are represented by a certain appearance and motion of a form: age, popularity, personal relevance, attention, feedback, and size.

In the menu on the right side of the screen, the user is able to modify these attributes. For example, the user can set the attribute age to new, medium, or old. Depending on the settings, the form on the right side is changing its appearance and motion.

There are many different ways how a form can look and move depending on the settings in the menu. It is possible to make the path of motion and the form matrix visible.


PRINCIPLE OF APPEARANCE
COMPLEXITY OF FORM
AGE
simple
new
complex
old
PRINCIPLE OF APPEARANCE
SYMMETRY OF FORM
POPULARITY
asymmetric
low
symmetric
high
PRINCIPLE OF MOTION
PULSATION
PERSONAL RELEVANCE
slow
low
fast
high
PRINCIPLE OF MOTION
SMOOTHNESS OF MOTION
ATTENTION
smooth
low
zigzag
high
PRINCIPLE OF MOTION
RADIUS OF MOTION
FEEDBACK
big
low
small
high
PRINCIPLE OF APPEARANCE
SIZE
PRINCIPLE OF MOTION
VELOCITY
SIZE
small
fast
big
slow
PATH OF MOTION
MATRIX OF APPEARANCE


PRINCIPLE OF APPEARANCE
COMPLEXITY OF FORM
AGE
simple
complex
new
old
PRINCIPLE OF APPEARANCE
SYMMETRY OF FORM
POPULARITY
asymmetric
symmetric
low
high
PRINCIPLE OF MOTION
PULSATION
PERSONAL RELEVANCE
slow
fast
low
high
PRINCIPLE OF MOTION
SMOOTHNESS OF MOTION
ATTENTION
smooth
zigzag
low
high
PRINCIPLE OF MOTION
RADIUS OF MOTION
FEEDBACK
big
small
low
high
PRINCIPLE OF APPEARANCE
SIZE
PRINCIPLE OF MOTION
VELOCITY
SIZE
small
big
fast
slow
PATH OF MOTION
MATRIX OF APPEARANCE

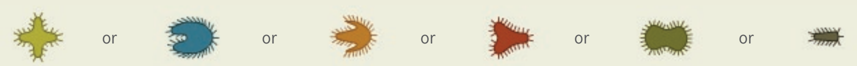
CASE STUDY
ANYMAILS

MY EMAIL INBOX

Anymails was developed with the help of my advisor Prof. Brian Lucid in Fall 2006 and Spring 2007. Florian Jenett coded the prototype in Processing, an open source language based on the Java programming language.

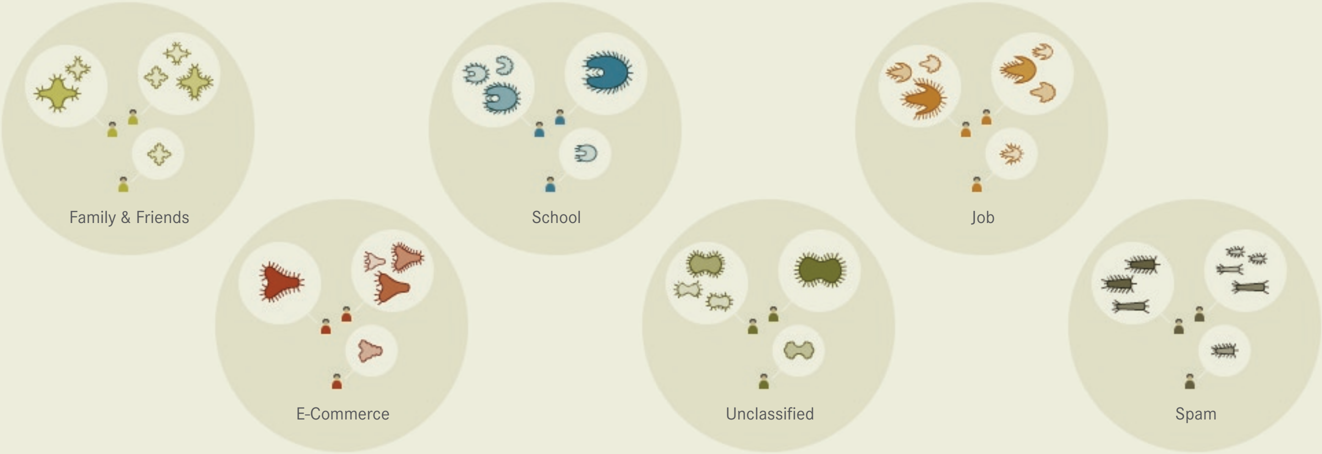
Anymails is a visualization of my received emails. This visualization is not a new email application but an experiment. I have investigated how I can use natural metaphors to visualize my inbox, its structure and attributes. The metaphor of microbes is used. My objective is offer the user another experience of his email world.

VISUAL SYSTEM



ONE EMAIL = ONE ANIMAL

One animal represents one received email.



ONE CATEGORY = ONE SPECIES

The emails are categorized in six person groups: family and friends, school, job, e-commerce, unclassified, and spam. For example, all emails I have received from my advisors and fellow students are in the category school. These categories are represented by six species, which are different in color and form. For instance, all received emails from school are blue and look a bit like croissants.


Family & Friends
new
old
unread
fast motion
read
medium motion
responded
very slow motion
School
new
old
unread
fast motion
read
medium motion
responded
very slow motion
Job
new
old
unread
fast motion
read
medium motion
responded
very slow motion
E-Commerce
new
old
unread
fast motion
read
medium motion
responded
very slow motion
Unclassified
new
old
unread
fast motion
read
medium motion
responded
very slow motion
Spam
new
old
unread
fast motion
read
medium motion
responded
very slow motion

STATUS AND AGE OF AN EMAIL = APPEARANCE AND MOTION OF AN ANIMAL

How an animal looks and moves depends on the condition of the represented email. The age of an email (when it was received) is shown by the size and opacity of the animal. For instance, a new email is big and opaque, an old email small and transparent. The age is defined in relation to other emails of a certain time period. The status of an email (unread, read, responded) is shown by two animal attributes: the number of hair/feet and velocity. An unread email is hairy and swims fast; a read email has less hair and does not swim so fast anymore; a responded email is hairless and barely moves.


25 26 27 28 29 30 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 1 2 3 4 5 6 7
MARCH 2006 ▲
▲ MARCH 2006
TIME
ANYMAILS
GROUPING
PREFERENCES
ABOUT

ANYMAILS

On the opening screen of my interface, all animals are swimming freely.
Only animals (emails) of a certain time period are visible at once, such as received emails from today.
The user can modify this period in the time line in the menu *Time*. He can decide if he wants to see emails from today, from the last week or month.
The animals represent the following information about the email inbox: The user can see the amount of received emails by the amount of animals. He can see how many emails he has received from which category by the different colored and formed animals. Are there more spam (brown animals) or more emails from family and friends (light green animals)? He can see the status of emails – which animals move fast or slow, which animals are hairy or hairless. For instance, if there are many unread emails from different species (categories), then the screen will be full of different colored and fast swimming hairy animals. If there are only a few responded emails, then only a few barely moving and hairless animals will be visible.


25 26 27 28 29 30 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 1 2 3 4 5 6 7
MARCH 2006
MARCH 2006
TIME
ANYMAILS
GROUPING
PREFERENCES
ABOUT


25 26 27 28 29 30 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 1 2 3 4 5 6 7
MARCH 2006
MARCH 2006
TIME
ANYMAILS
GROUPING
PREFERENCES
ABOUT


SPECIES
STATUS
TIME
ANYMAILS
GROUPING
PREFERENCES
ABOUT

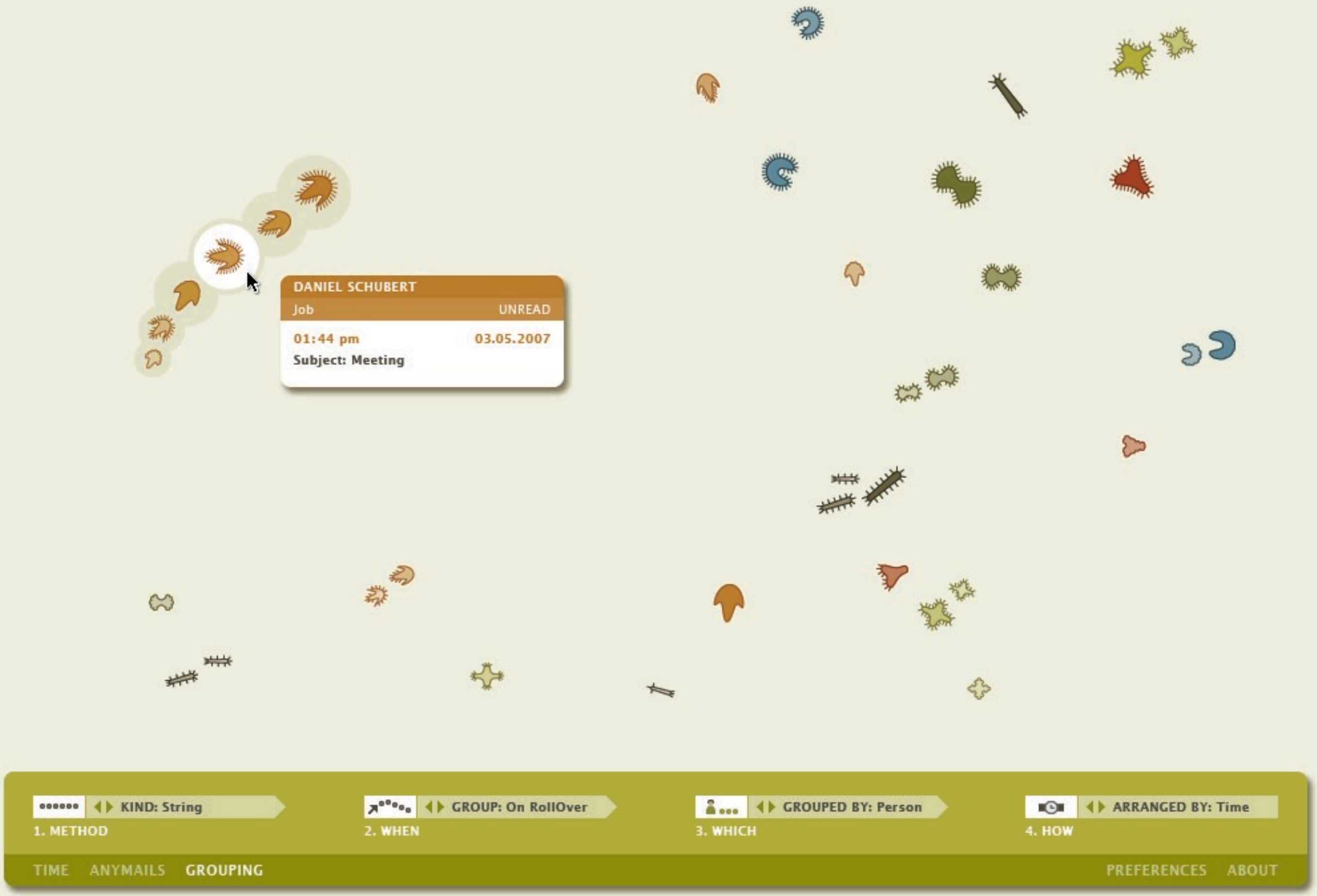
FILTER

The user can filter emails by species and status in the *Anymails* menu. There are buttons for each species and kind of status. He can fade in or fade out certain species like spam. Or he can make all unread emails visible or invisible. For instance, he can combine these filters to see only emails from school, which are unread.

The impression of the inbox can be really different depending on which species or which status is visible or not. For instance, I receive a lot of spam emails everyday so my screen is full of brown worms. My other animals seem to be attacked by this superiority. If I fade out the species spam, everything seems to be calmer and less aggressive.

TIME TRAVEL

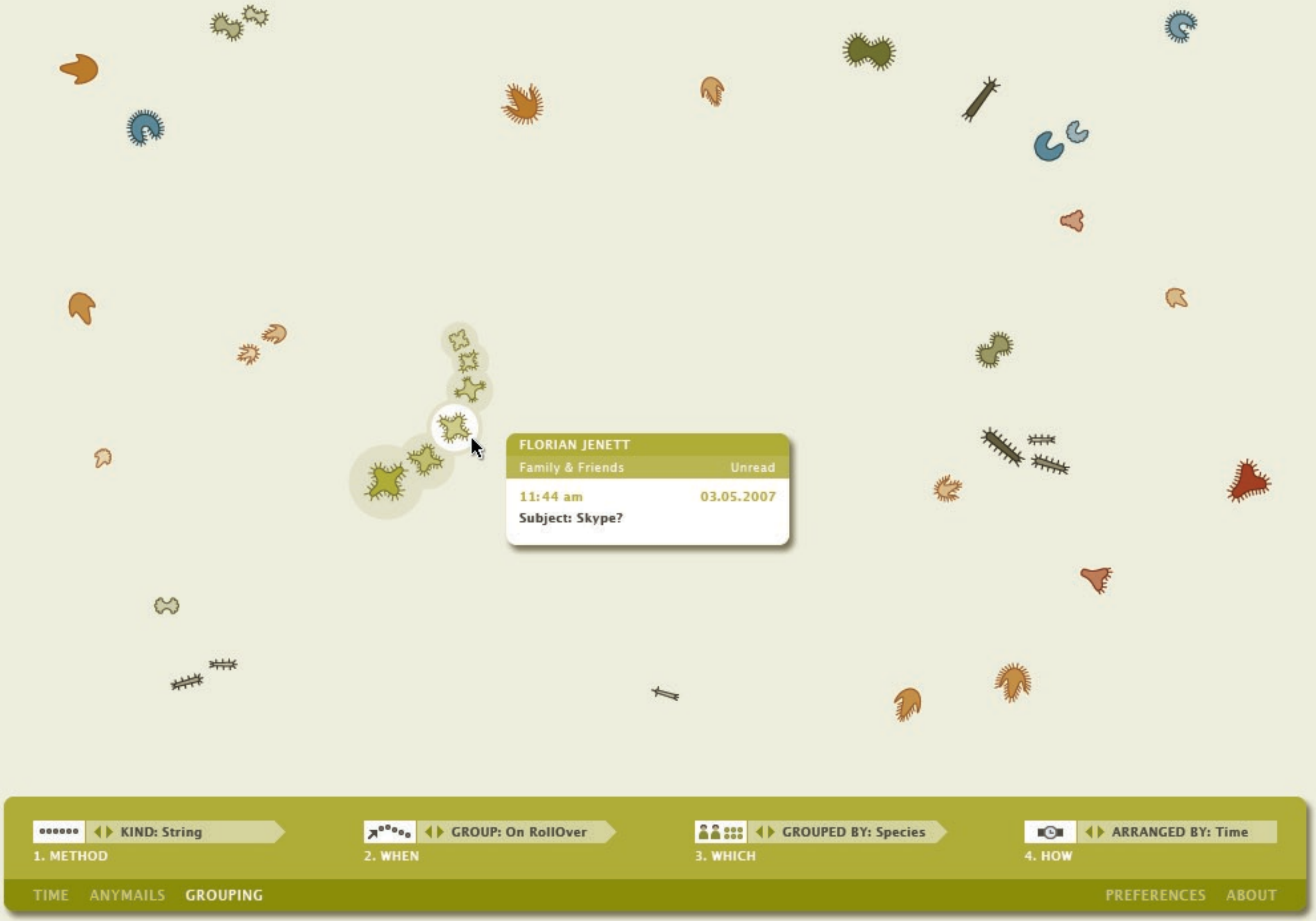
The user can go back in time to see emails received over the last months or years. In the menu *Time*, he can scroll through the time line to previous inbox conditions. The user can compare different times; he can recognize patterns. When has he received more or less emails? When have more relatives and friends sent emails, when more people from school? When has he responded more or less emails? Is there a relation between these patterns and personal circumstances? For instance, I can recognize certain patterns, which I can connect to personal life circumstances. I received a lot of emails from my family and friends in the first weeks after leaving Germany to study in the USA. In this time period my screen is filled with light green animals. At the time I worked as a freelancer, the screen is filled with job emails respectively orange animals. These patterns reflect certain life circumstances.

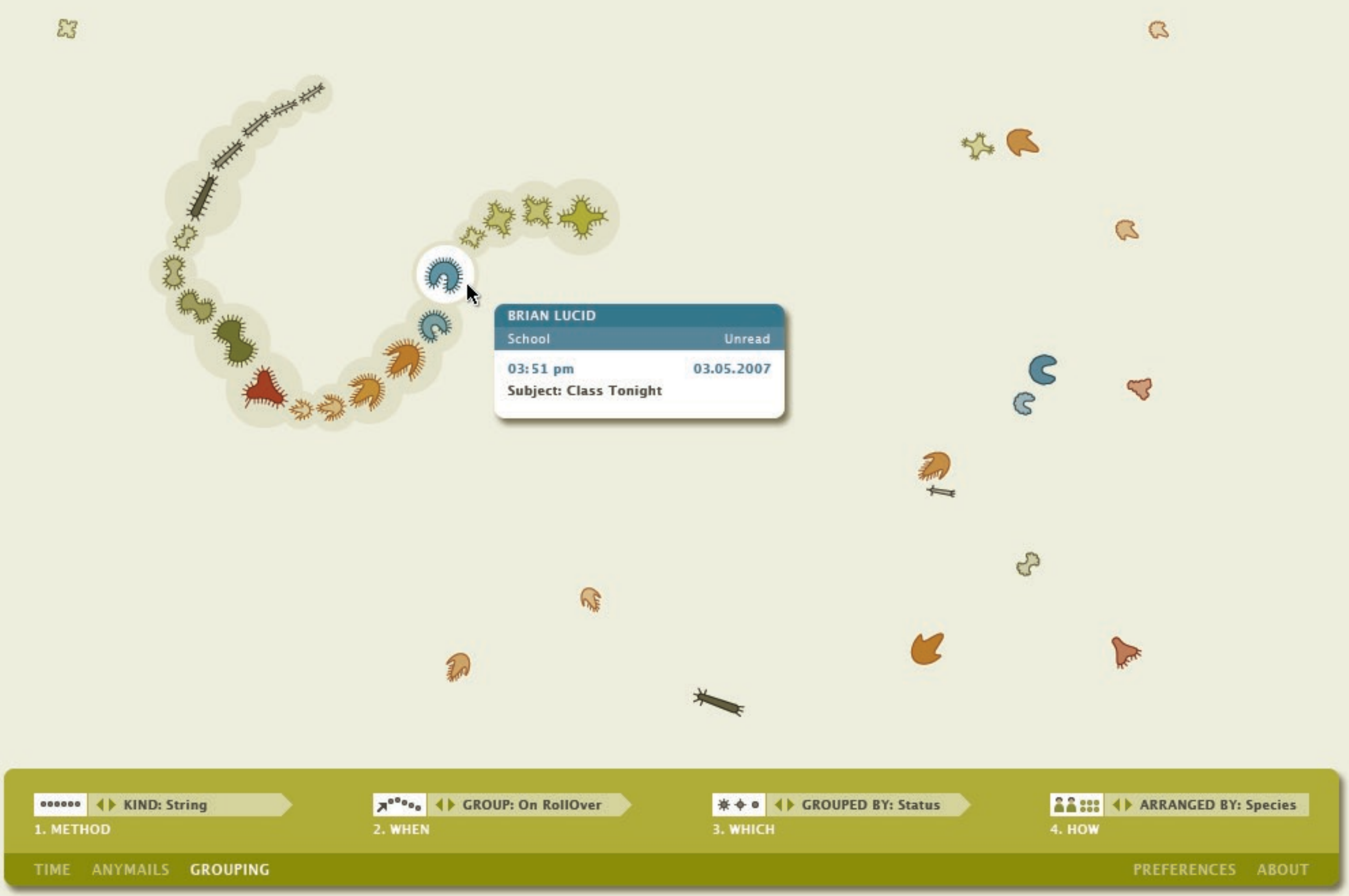

DANIEL SCHUBERT
Job
UNREAD
01:44 pm
03.05.2007
Subject: Meeting
KIND: String
1. METHOD
GROUP: On RollOver
2. WHEN
GROUPED BY: Person
3. WHICH
ARRANGED BY: Time
4. HOW
TIME
ANYMAILS
GROUPING
PREFERENCES
ABOUT

ROLLOVER AND GROUPING BEHAVIOR

Selecting one animal, triggers different thing at once. First, a text field appears, containing information about the email (name of sender, status, delivery day and time, subject line). In addition, related animals swim next to the chosen one and group in form of a string. The other animals do not group and move away from the string. The user can define which emails are related in the menu *Grouping*. He has the choice between: emails from the same sender, from the same species, with the same status, or from similar delivery time. For instance, the user decides that emails from the same sender are related. When he selects one email, all emails from the same sender swim next to the chosen one and group. Emails from other people move away and do not group. The user can also decide how the emails are arranged in a string. He is able to sort the emails by status, time, size, person or species. For instance, the user can arrange the emails from the same person inside the string by time. Then newer emails (bigger and opaque) are in the beginning and older emails (smaller and transparent) are at the end of the string.

This grouping behavior offers the user additional information, such as the amount of emails he has received from one certain person. The position of the animal, the spacial relation to other animals, gets meaning. Animals, which are related, are close together; they are bonded together. Other animals, which do not belong to this group, avoid it. The user becomes an explorer through this interactivity. He becomes curious about what will happen when he catches one animal. Will other animals come, which and how many?


FLORIAN JENETT
Family & Friends
Unread
11:44 am
03.05.2007
Subject: Skype?
KIND: String
1. METHOD
GROUP: On RollOver
2. WHEN
GROUPED BY: Species
3. WHICH
ARRANGED BY: Time
4. HOW
TIME
ANYMAILS
GROUPING
PREFERENCES
ABOUT

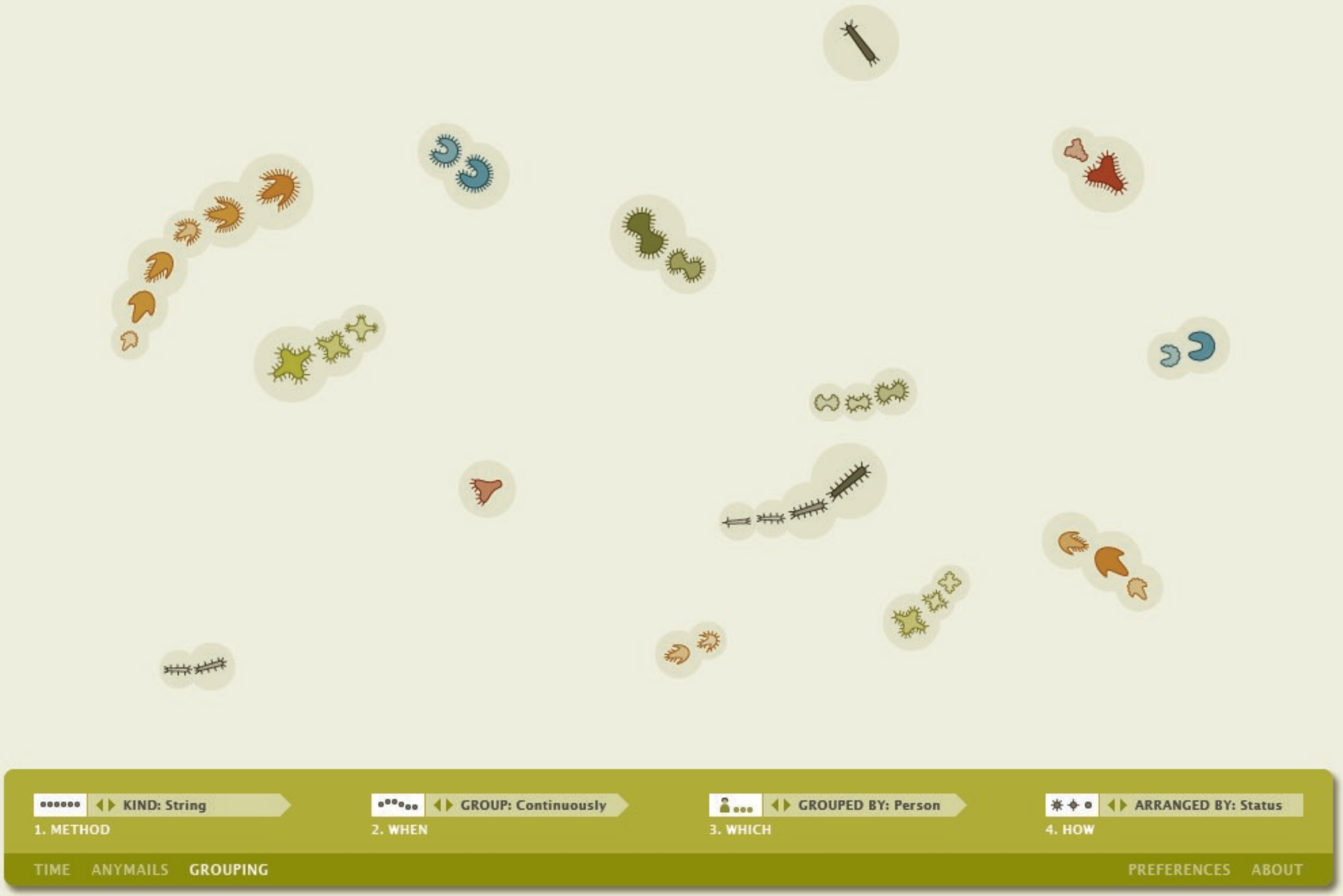

BRIAN LUCID
School
Unread
03:51 pm
03.05.2007
Subject: Class Tonight
KIND: String
1. METHOD
GROUP: On RollOver
2. WHEN
GROUPED BY: Status
3. WHICH
ARRANGED BY: Species
4. HOW
TIME
ANYMAILS
GROUPING
PREFERENCES
ABOUT


KIND: String
1. METHOD
GROUP: Continuously
2. WHEN
GROUPED BY: Status
3. WHICH
ARRANGED BY: Species
4. HOW
TIME
ANYMAILS
GROUPING
PREFERENCES
ABOUT

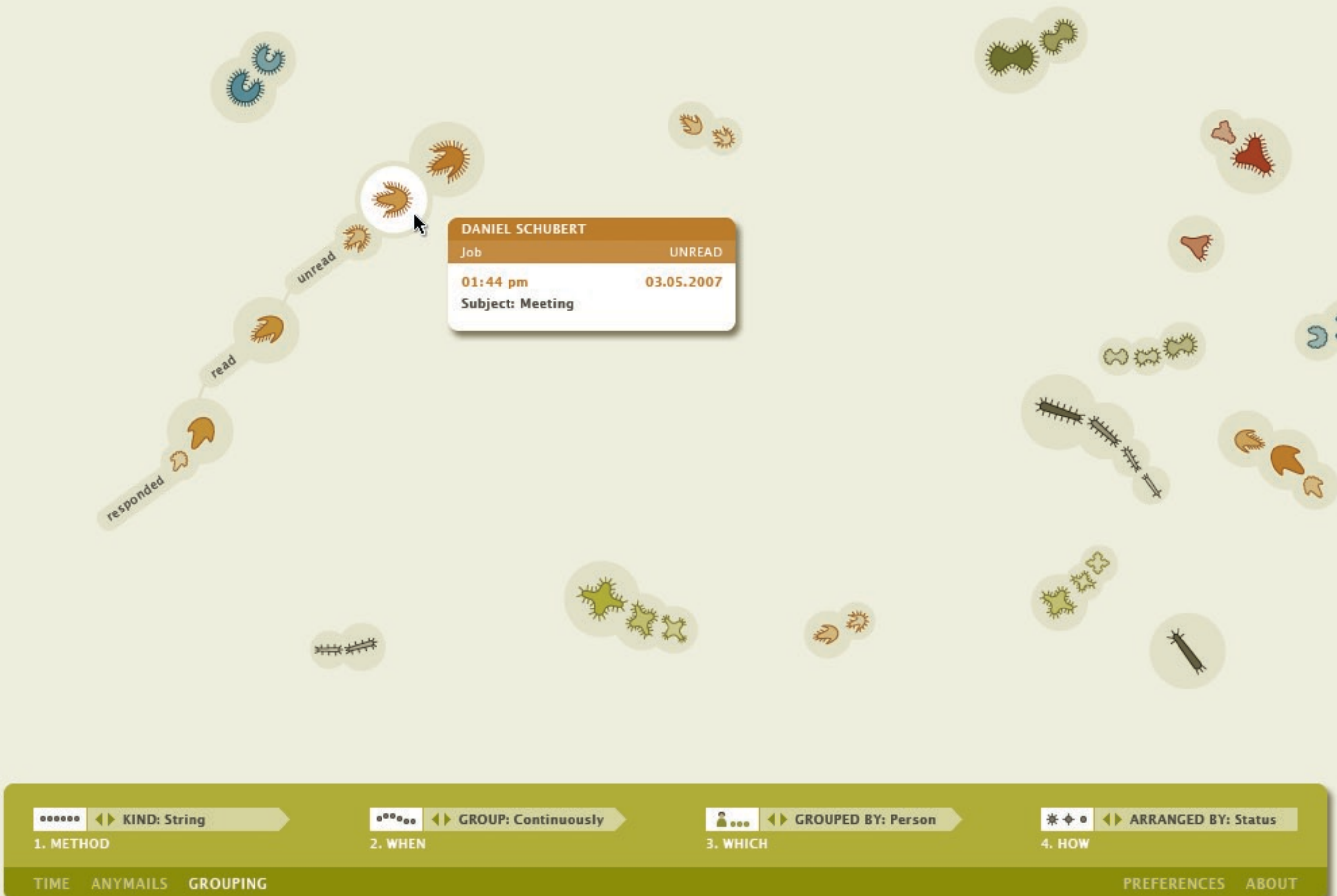
GROUPING CONTINUOUSLY

The user can group emails continuously. In this mode all emails are grouped in the form of strings. As in the rollover mode, the user can define which emails are grouped and how they are arranged in the groups. Depending on which emails should group, the animals form a few longer strings or a lot of shorter strings. For instance, if the user decides to group the emails by status, the animals will form three strings. One contains all responded emails, one all read ones, and one all unread ones. If the user decides to group emails by the same person, the animals will form several strings, each containing emails from one person. How many strings will be formed, depends on the user's email traffic. For instance, if he received many emails from only a few people, only a few, long strings would form. If he received only a few emails from many different people, many different but short strings would form. This grouping mode is not visible at once; it evolves. The animals swim towards each other, arrange themselves and form a string. It offers a completely different view. The screen full of freely swimming animals becomes a screen full of animal strings. These strings move fast or slow depending on their members. For example, a string containing a lot of unread emails moves faster than a string containing more responded emails.

In this mode the user can quickly recognize the structure of his inbox in a certain time period. He can see how many emails he has received from certain people, how many different people have sent emails, how many emails he has received from certain species, and so on. For example, the user can see how the email string of a certain sender is changing over time. The string becomes bigger, smaller, bigger again depending on the continuousness of email traffic.


KIND: String
1. METHOD
GROUP: Continuously
2. WHEN
GROUPED BY: Person
3. WHICH
ARRANGED BY: Status
4. HOW
TIME
ANYMAILS
GROUPING
PREFERENCES
ABOUT


KIND: String
1. METHOD
GROUP: Continuously
2. WHEN
GROUPED BY: Species
3. WHICH
ARRANGED BY: Status
4. HOW
TIME
ANYMAILS
GROUPING
PREFERENCES
ABOUT


DANIEL SCHUBERT
Job
UNREAD
01:44 pm
03.05.2007
Subject: Meeting
unread
read
responded
KIND: String
1. METHOD
GROUP: Continuously
2. WHEN
GROUPED BY: Person
3. WHICH
ARRANGED BY: Status
4. HOW
TIME
ANYMAILS
GROUPING
PREFERENCES
ABOUT

UNCOMPRESSING

The user can uncompress strings. The more he stretches a string the more information he gets about the contained emails. Small text labels become visible which show, for instance, where unread, read, responded emails are located.

OTHER CONCEPTS

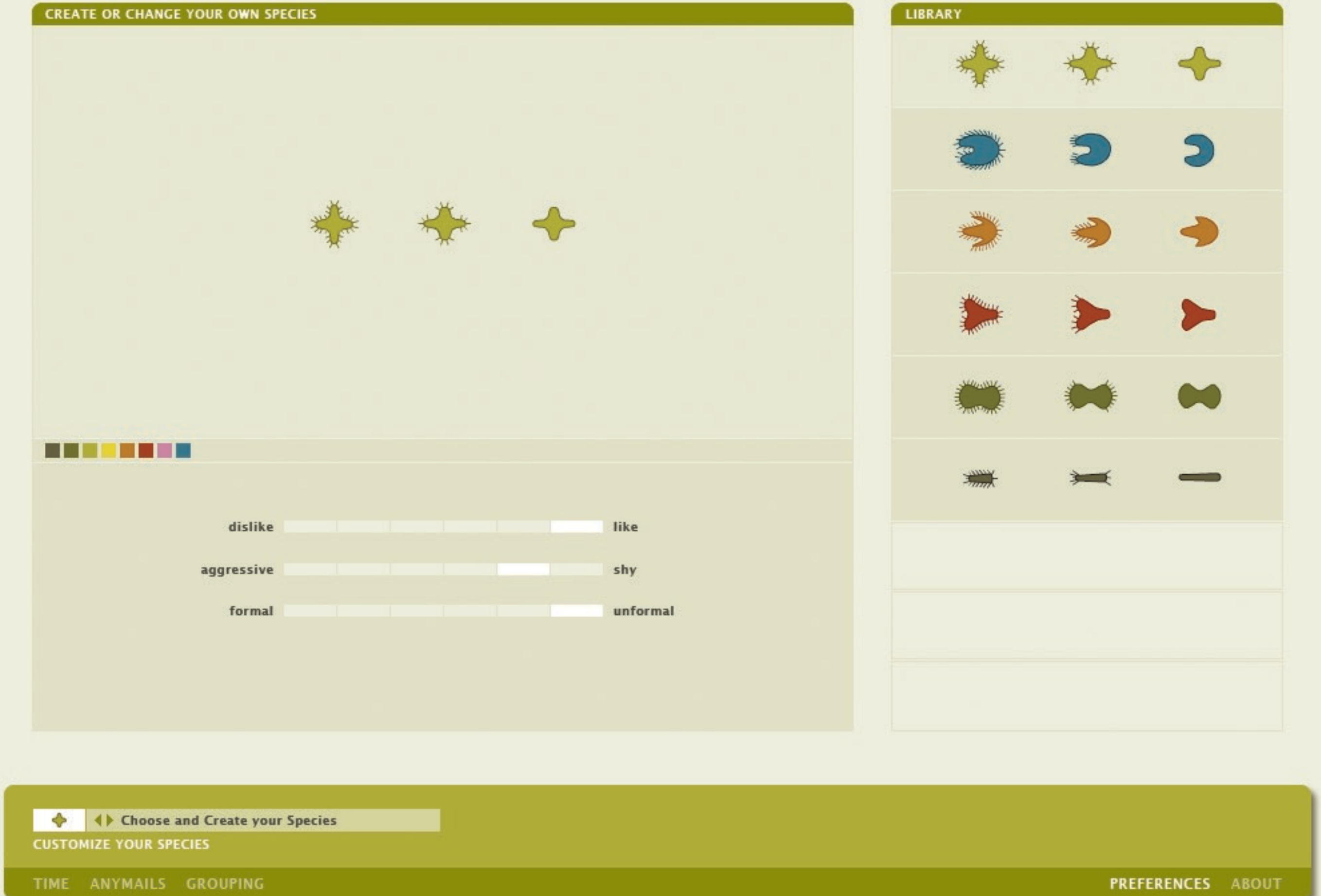
Other concepts emerged during my work on *Anymails*. They are not included in the prototype, but show how the case study could be further developed. Are there other grouping methods to arrange emails? Which are the interactivities to customize the visualization?

CUSTOMIZED ANYMAILS: PREFERENCES

Right now *Anymails* is a visualization of my emails. The user should be able to customize the visualization to his inbox. For instance, the user could arrange his emails by own categories. Not everyone would like to have the current categories; maybe someone wants to have less or more. The user could also decide which species represent which category, in which color a certain species is.
Maybe users could create their own species. One idea is that the user creates species by giving information about certain person groups. How formal or informal are the emails from this group? How much does the user like or dislike these emails? How aggressive (demanding) or shy are these emails? For instance, my family and friends species is very informal, I like them very much, they are shy because my family and friends understand and accept when I do not respond immediately. This is only a concept; this kind of tool would require further investigation. How much freedom has the user in this creation process? Which rules have to be developed to ensure that created species can be differed at the end?

Changing categories, modifying or creating species offers a customized visualization. Then *Anymails* enables the user to draw conclusions about his personal inbox, to uncover own pattern inside his emails. It also supports his understanding about the different species. For instance, when he defines the color of certain species, he can give them a certain personal meaning. He loves blue and because of this his family species is blue. Then he can easily remember the color-coding during the running application.

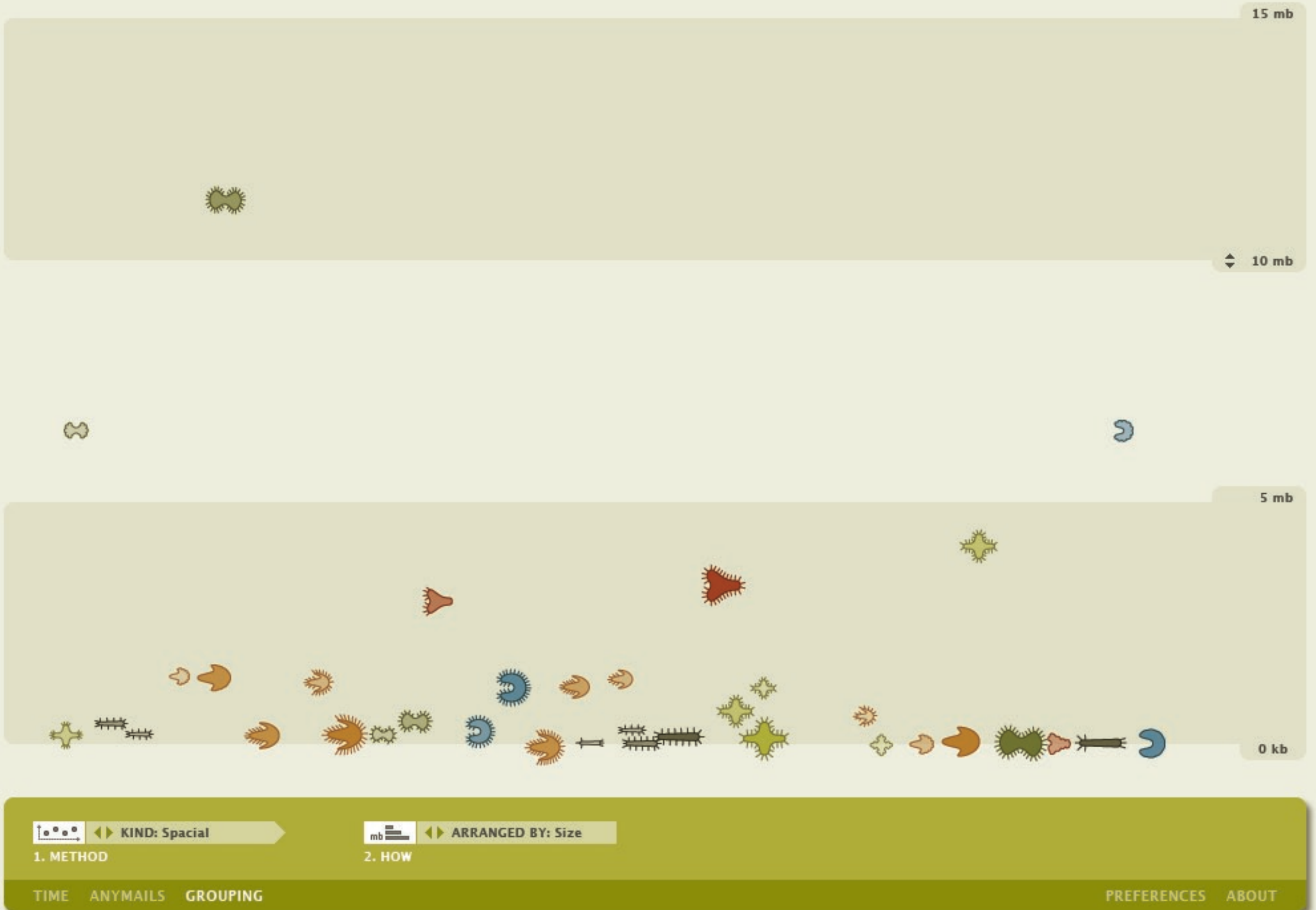

FRIENDS & FAMILY
Florian (mail@florian.de)
Ulrich (mail@ulrich.de)
Christa (mail@mum.de)
Susanne (mail@spud.de)
Micha (mail@micha.de)
Kai (mail@kai.de)
Isa (mail@isa.de)
Kathrin Schön (mail@kathrin.de)
Elisabeth (mail@rot.de)
Lauren (mail@lauren.com)
SCHOOL
Brian (mail@brian.com)
Jan (mail@jan.com)
Joe (mail@joe.com)
Gunta (mail@gunta.com)
Erich (mail@erich.de)
Uli (mail@uli.de)
Detlef (mail@detlef.de)
Kurz (mail@kurz.de)
Hochmuth (mail@hochmuth.de)
Daniela Schubert (mail@daniela.com)
JOB
Jan (mail@jan.de)
Patrick (mail@patrick.de)
Corinna (mail@corinna.com)
Sebastian (mail@sebastian.com)
Norbert (mail@norbert.de)
Daniel (mail@daniel.de)
Fujii (mail@fujii.org)
Christiane (mail@christiane.de)
Peter (mail@peter.de)
Silke (mail@silke.com)
E-COMMERCE
Amazon (mail@amazon.de)
Ebay (mail@ebay.de)
Blumen (mail@blumen.de)
Netflex (mail@netflex.de)
Nishnash (mail@nishnash.com)
Skype (mail@skype.de)
Deutsche Bank (mail@dt.de)
Bank of America (mail@boa.com)
Craigslist (mail@craigslist.com)
Hostelworld (mail@hostel.com)
UNCLASSIFIED
Lorenz (mail@lorenz.de)
Martin (mail@martin.de)
Joseph (mail@joseph.de)
Norbert Sim (mail@norsim.de)
Melanie Theis (mail@theis.com)
Simone Hubert (mail@hubert.de)
Dagmar Schmidt (mail@schmidt.de)
Julia Haus (mail@julia.de)
Oliver (mail@oliver.de)
Balu (mail@derhund.com)
SPAM
Casino Null (infomail@casino.de)
Angebot (mail@angebot.de)
Uschi (mail@uschi.de)
Dieter (mail@dieter.de)
Claudia (mail@claudia.com)
Verena (mail@verena.de)
Miriam (mail@miriam.de)
Stephanie (mail@steffi.de)
Alexandra (mail@alex.de)
Wackeldackel (mail@wackeldackel.com)
Name your Species and Organize your Sender
CUSTOMIZE YOUR SPECIES
TIME
ANYMAILS
GROUPING
PREFERENCES
ABOUT


CREATE OR CHANGE YOUR OWN SPECIES
LIBRARY
dislike
like
aggressive
shy
formal
unformal
Choose and Create your Species
CUSTOMIZE YOUR SPECIES
TIME
ANYMAILS
GROUPING
PREFERENCES
ABOUT


RESPONDED
READ
UNREAD
KIND: Spacial
1. METHOD
ARRANGED BY: Status
2. HOW
TIME
ANYMAILS
GROUPING
PREFERENCES
ABOUT

SPACIAL GROUPING: STATUS

The user can group emails spacially. The emails are forced to swim in certain areas according to their status. Unread emails are only allowed to move inside the inner cycle. Read emails are only allowed to swim in the middle cycle. Replied emails are only allowed to swim in the outer cycle. The size of these cycles can be changed to give, for instance, unread emails more space to move.


15 mb
10 mb
5 mb
0 kb
KIND: Spacial
1. METHOD
mb
ARRANGED BY: Size
2. HOW
TIME
ANYMAILS
GROUPING
PREFERENCES
ABOUT


15 mb
1 mb
500 kb
0 kb
KIND: Spacial
1. METHOD
ARRANGED BY: Size
2. HOW
TIME
ANYMAILS
GROUPING
PREFERENCES
ABOUT


15 mb
1 kb
0.5 kb
0 kb
KIND: Spacial
1. METHOD
mb
ARRANGED BY: Size
2. HOW
TIME
ANYMAILS
GROUPING
PREFERENCES
ABOUT

SPACIAL GROUPING: SIZE

A coordinate system is used to arrange emails by their size in bytes. In this mode emails can only move horizontally. Their horizontal position indicates their size – emails with less kilobytes (kb) swim at the bottom, emails with more kilobytes swim more above.

When I look at my emails, I notice that 99 per cent of them are between 0.1 and 5 kb big. Only a few are bigger than 5 mb (1 mb is 1000 kb). Because of this, a huge crowd of emails swims at the bottom of the coordinate system. The coordinate system is flexible to resolve this crowd. The user can change the scale; he can stretch the coordinate system. For example, he can define that two-thirds of the screen show emails between 0.1 and 10 kb and only one-third emails between 10 kb and 15 mb. This allows users to see detailed size differences between smaller emails.


10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
MARCH 2000
APRIL 2000
TIME
ANYMAILS
GROUPING
PREFERENCES
ABOUT

FOOD

Another concept is to integrate the metaphor of feeding. The user can place food sources, which attract only certain animals. These animals swim close to the food. This could work like a search option. For example, the food attracts only emails from certain persons, or with certain subject lines.

DELETE

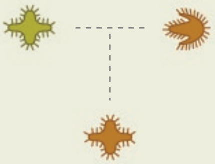
People have often asked me if they could also kill animals. The visualization could become more like a game. The user has to show certain skills to delete an email. Only if he hits an animal with a weapon, it will be deleted. Moral concerns may be disregarded ...

TRACKS

The metaphor of tracks can be used to indicate the email history of certain senders. For example, emails from people who have written me constantly in the past, leave tracks. The length of tracks indicates the consistency of email traffic.

MOUSE ATTRACTION

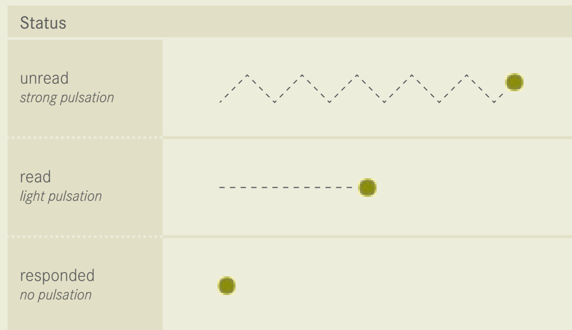
The user and his cursor could influence more the behavior of animals. For example, the user can define that emails from one friend are more attracted to the cursor. When he travels through different time periods, he can quickly see how often his friend has written through the time. These emails try to follow the cursor.



GENETICS

Right now, each sender is an exclusive member of a species. But sometimes I have worked with a person who is also a friend. Do his emails belong to the species family & friends or job? The concept of genetics can be integrated to solve this problem. The animal, which represents the email of this person, is a mixture between job and family & friends animal. For instance, it has the color of job animals and the form of family & friends animals. Of course, this needs further investigations. Which visual attributes of both are integrated? Is there a dominant attribute of one of the parent animal? How easy it is to identify the parent animals?


Importance & Age
new
old
very important
symmetric
less important
less symmetric
unimportant
asymmetric


Status
unread
strong pulsation
read
light pulsation
responded
no pulsation

ABOUT ANYMAILS

DEVELOPMENT

My work on Anymails is characterized by the development from abstract to more concrete forms, from mechanical to natural motions, from complex to simpler visual code.

(1) In the beginning of the project, the age of an email was indicated by smoothness of form: a new email was smooth; when it became older it got more and more wrinkles. The created forms were very abstract. The code, the meaning of certain forms, was hard to memorize. I did not organize the emails by person groups. I created three levels of importance: very important, less important, and unimportant. These levels were indicated by symmetry of form: a very important email was symmetric like a cycle; an unimportant email was asymmetric. I had problems including motion as an attribute. It was difficult to move these forms without losing their form and its connected meaning. The result was a very mechanic motion such as pulsation. This was not only stressful to watch, but the motions could not be easily differentiated. For instance, unread emails moved on a zigzag path and pulsed strongly. Read emails moved on a smooth path and pulsed lightly. Responded emails did not move.


VIEW
Category
family
friends
school
job
others
junk
Time
new
medium
old
Status
unread
read
read & responded
GROUP
Grouping
only by rollover
steady
Grouped by
single person
category
Arranged by
status
time
OPTIONS
PREFERENCES
ABOUT
DEZEMBER 15th 2006
06:20 pm

(2) There was definitely the need to create formal and motion attributes, which could be easily recognized. I decided to organize my emails by person groups and to represent these by species. I created simpler coded forms, which are still basis of some current animals of my visualization. The age of an email was represented by the opacity; the status was represented by size and velocity. For instance, a new unread email was big and opaque and swam fast, an old responded email was small and transparent and did not move. I also started to experiment more with motion. I wanted to create the impression that these forms are swimming. Overall I was not satisfied. The forms were not animals; they were still too abstract, as was the code. They seemed to be bubbles, which swam different in color and motion over the screen.

(3) I noticed, that code becomes easier to understand when one email attribute like age is shown by more than one visual attribute. Age is represented by size and opacity. Status is represented by amount of hairs and motion. Category (person group) is represented by form and color. This was also a further step towards natural metaphors; the abstract forms became animals. The motion of these animals also changed according to their form. The spam started to crawl, the job animal to push itself forward, and so on. The first time, I got the impression to observe something alive.

METAPHOR

I intended to use natural metaphors from the beginning of *Anymails*. But the particular metaphor and its use evolved in the process as it did during my work on Jellyfish. In contrast to *Jellyfish*, where I only use metaphors to visualize structures, I additionally use metaphors to visualize attributes like the age of emails in *Anymails*. For the inbox visualization I needed the metaphor of an animal, which appears in large numbers, like received emails. The idea emerged to use microbes as representatives. Some people associate viruses with the animals, but that metaphor works too. One can believe that microbes or viruses appear in bigger swarms. Motion and certain behavior patterns can be integrated as well. We can imagine, that microbes or viruses move and form groups. My intent was to create a micro world through which the user can explore his email world, like watching small animals through a microscope.

VISUALIZATION

When people watch *Anymails* for the first time, they often miss the clarity, which common email applications offer. For instance, in common applications the user can quickly find a wished email by using rearrangements of lists or using the search option. Everything is in order, which gives us the feeling of control. We want to have control. Emails are important for us, we do not want to miss one, we want to respond to an email fast enough, and we do not want to lose them. I can understand this; *Anymails* is not an alternative for such email applications; the user cannot find a certain email in such speed. I made this on purpose. I have dissolved the common clarity to experiment. Can I offer a richer experience by doing so? I did not want to create a new email application but a visualization of my emails, which offers a different point of view.

In common email applications, the user gets information about the amount of received emails in the form of exact numbers. The emails are arranged in a list; the length of the list additionally indicates the amount of emails. But the user cannot really understand what 100 or 200 emails mean. The amount is often not visible at once; he has to scroll through the list. In *Anymails* the amount of emails is represented by the amount of animals. Thereby it offers a completely different view if someone has received 5, 100, or 200 emails. It can become an experience for the user. A certain view can trigger feelings. I play with and amplify feelings, which the user already connects to his emails. For example, he feels overextended when he has to respond to many emails, he feels overrun when he gets too many spam emails, he feels disregarded when no friend or relative writes an email, and he is happy when he gets one. These experiences are exemplified partly by the animals. For instance, when I receive only five spams one day, these animals seem to be nice and funny how they swim around the screen.

When I receive 200 spams one day, these animals loose their nice impression. In bigger swarms they seem to be aggressive, and I feel overrun by them. When I only receive a few family emails, these animals seem to be lonely. Other animals, like spam, push visually them away.

Another important aspect is the comparison of different sender groups. For example, how many emails are sent by schools or companies? In common email applications the user can arrange the email list by person but this option does not offer a real comparison. He can organize the emails by sender groups in different folders. Then the user clicks on one folder and get its email list, then he clicks on another folder and gets another one. But still he cannot really compare the amounts. In *Anymails* the user sees the amount of emails of different sender groups in relation to each other. Each sender group has its own color and all groups are displayed at once. A colored pattern emerges which the user can interpret easily. Is one group more dominant or another one? Is the screen colorful or only two colored? Are there more job or school emails? The user understands information not by numbers but by visual patterns. These patterns are not static; the status of an email is represented by its motion. It is a dynamic colored pattern that shows how much attention the user has given to emails of certain sender groups. Has he answered more family or school emails? Are there more replied, read or unread emails? For instance, when the user has not read or answered many emails, he sees many fast swimming animals. He can panic like his animals when he thinks about how many emails he must reply to. When he already has read and answered many emails, the animals are calm; they swim slow or barely. Depending on his attention he sees an accordant moving pattern.

In common email applications the user cannot experience time. He can arrange emails by time but he cannot experience time differences between emails, the change during time. Emails are only arranged one after another. In *Anymails* the user can travel through different time periods of his inbox; the visual patterns are changing according to past conditions. He can see how far emails are seperated temporally; he can understand the amount of emails in context of time. When has he received more or less? When have friends or people from school written more or less emails? When has he responded to more or less emails? The user can set these patterns in context to actual life circumstances. The patterns get personal meaning. For instance, I can recognize when I had semester break (less school emails), when I was working (many job emails), when I had a stressful time (many unanswered emails), when I was abroad (many family emails).

Anymails allows the user to uncover patterns within the body of data, which are hidden within a list display.
The missing static arrangement of emails takes its toll. The user cannot quickly find a certain email in *Anymails*. But the user can discover a new email world. His inbox becomes, through natural metaphor, a micro world, one which he has to observe and interact with before he can interpret certain conditions.

INFORMATION VISUALIZATION THROUGH NATURAL METAPHORS

HUMAN PERCEPTION,
NOT BIOLOGICAL EXPERTISE

Human perception is the foundation for my metaphors. The user does not need biological expertise to understand visual and behavioral metaphors. The metaphors are based on classic perception and on personal observation – how humans perceive and interpret the natural environment.
Why and how do we know that subjects belong together? How do we interpret which behavior? Which attribute has which meaning? Which attribute is connected to a certain behavior? What is perceived first, what later?

NATURAL PATTERNS

How can natural metaphors represent information attributes and conditions? I had to find attributes and conditions in our environment which users can interpret similarly, which have a uniform meaning. Then I can use these patterns for metaphors to mediate information. Of course, not everything underlies a uniform pattern in nature and perception of nature. One main characteristic of nature is the variety of forms of lives, motions and behaviors. And every human interprets the environment differently based on his previous experiences, his standard of knowledge, and his cultural background. But certain form, motion and behavior can have a uniform meaning for us when they conform to natural patterns.

These are principles based on recurring processes in nature. There is similar form, motion, and behavior in nature as a consequence of physical and emotional conditions of a subject (like age and health), and as a consequence of external conditions (like climate and food supply). The first reason for these patterns is that we all live in the same world and its conditions. The second reason is that we all have the same primary motive: to survive as an individual (like prevention of injury) and to ensure the survival of our species (like reproduction). For example, we all try to eat food when we are hungry. Hunger (cause) and eating (behavior) is a natural mechanism to ensure body functions. We know which form, motion, behavior has which meaning because of previous observations, experiences, or instincts. We use these patterns to interpret other humans. For example, we all change our appearance in similar steps during life. First we are small, we grow and grow, and become older. Based on these patterns we can rate the age of people. By interpreting animals and plants, we tend to attribute our own familiar behavior and motives to them when we do not have an objective knowledge (see *Perception of Motion: attribution theory*). When we compare ourselves to them, their forms, motion, and behavior obtain meaning. We can interpret the physical condition of an animal by observing its motion. For example, when my leg is hurt, I hobble. When I see a dog hobbling, I can infer that it is also hurt. We can also interpret the physical condition of an animal by observing its form. For example, when I do not eat enough, I become slim. When I see a thin cat, I can infer that it also does not eat enough. We can interpret the external conditions or situations in which an animal finds itself by observing its behavior. For example, when I am in danger, I try to run away. When I see animals run away, I can infer that they are in danger, too.

Summarized, form, motion and behavior of livings subjects act as an indicator for attributes, conditions of a subject, its living space and situation; and in general we interpret them similarly.

NATURAL METAPHOR TO REPRESENT INFORMATION

INFORMATION AND “LIVE” FORMS

Animals and plants have attributes and conditions just as information does. There are similarities between them, for instance, an animal becomes old like information becomes old. Form, motion and behavior of living subjects have meaning; they indicate their attributes and conditions. Motion and behavior of information representatives have meaning; they visually mediate attributes and conditions of information. Living subjects are changing; they react on and adapt to environmental influences; they are dynamic. For instance, long term evolution is changing animals, plants and humans to enable them to adapt to new external conditions. Trees change their appearance depending upon the season. The nature of information is also dynamic. For instance, the amount and attributes of information is changing, like in my email inbox.

NATURAL CODE

Information designers use visual codes (pattern with meaning), to represent information. These codes are often abstract. For instance, different colored squares represent different categories. I also use visual codes. These codes are forms, motions and behaviors of my natural metaphors. The difference to common codes is that these natural codes can be derived from our experience in the real world; they are less abstract. For instance, in *Anymails* the status of an email is shown by the form and motion of an animal.

When an email is unread, the animal is hairy and moves fast. When an email is responded to, the animal is hairless and moves rarely. In the real world, we connect fast motion to something unused and fresh, whereas we connect slow motion to something exhausted. I used this principle to visualize the status of emails: information that is not seen moves fast; information that is already used moves rarely. We can understand and memorize this code quickly because of its connection to our experiences in the real world.

NATURAL STRUCTURE

PERCEPTION PRINCIPLES

How can I structure information through natural metaphors? I had to find general characteristics (visual and behavioral), which humans need for recognizing a structure. In perception theory these characteristics are defined as perception principles. They describe by what and how we generally perceive structures, the means by which we know what things belong together or not. These principles are based on our environmental perception. For instance, the law of proximity: when I am observing two people on a street, I can conclude from their proximity to each other if they belong together or not. Information designers use this perception ability as a principle to visually connect or separate information.

Other principles, like uniform connectedness, common fate, similarity, closure, good continuation, figure-ground relationship, etc. work in the same way (see *Perception of Static Representatives).* These perception principles are often used in a static and abstracted way. The concentration lies more on visual than on behavioral principles. Not a certain behavior but a placement, as in a coordinate system, or appearance, like color, tells us the relation of two elements. Information representatives are often abstract, like typography. For example, contents of a common web site are connected by placing their menu items (text in colored box) next to each other.

PERCEPTION PRINCIPLES IN MOTION

My visualizations are based on the same perception principles; I only use them differently. First, I use natural metaphors to represent information attributes and conditions instead of abstract forms. Second, I use these perception principles in motion. I part with a static coordinate system and use behavior and motion as a classification system to visualize information structure. By doing this, I express these principles through natural behavioral metaphors. For example, in the case study *Jellyfish* the structure of the encyclopedia is shown by the grouping behavior of jellyfishes. There is no static coordinate system which defines the exact position, like x=80 and y=90, of information representatives. The structure is visualized by jellyfishes moving together and apart, by grouping or avoidding each other. I do not use the real behavior of animals. Few users (myself included) know how jellyfishes or microbes group. The behavioral metaphor is based on principles of how we perceive and interpret social structures in general. For instance, when I enter a room full of people, I can infer who belongs together and what the relationship between people is by observing their behavior. Who is always close to someone else? Is there physical contact? Who avoid each other? Based on behavior patterns, I can understand the social structure. I used the same patterns for *Jellyfish* and *Anymails*. Thereby I have simplified these patterns. I have reduced them to basis patterns to make them easier to understand, for instance the law of proximity in motion (grouping behavior). I used also others principles, such as the law of similarity (elements that are similar in color, form, size, motion tend to be grouped together) and velocity (elements moving in the same speed tend to be grouped). In the case study *Anymails*, for example, emails move in certain velocity depending on their status: slow, medium, fast. By observing the motions the user perceives emails with the same velocity as a group. The law of synchrony (elements that change at the same time group together) is also used. For example, when emails start to form a string, they change their motion path at the same time in order to group.

Because of this synchrony, they are perceived as a group before they actually form a group. I also used the principle of common fate (elements moving at the same direction tend to be grouped).
For example, when emails are grouped they move all in the same direction, they follow each other.

SIGNIFICANCE OF PERCEPTION PRINCIPLES IN MOTION

The user has to observe behaviors before he can interpret information and its structure. In the real world, the interpretation of social structures (human or animal) underlies a process, too. For example, first I observe two strange people then I can tell if they are a couple or only friends. How long I need to interpret a social structure depends upon my experiences, previous knowledge, and of course, on the complexity of the structure. At first glance requiring observation for understanding information refutes classic rules of information design. Designers try to visualize information in a way that it can be interpreted as fast as possible. But Nathan Shedroff, author of “experience design”, describes well what these natural structures can offer: “Think about a game in which all the pieces are already arranged or in which the sequence of moves is predetermined and

carefully and logically laid out. It wouldn't be very much fun to play. There may be other times when random organizations present a better experience than an orderly one, and it is up to us to explore those possibilities and employ good judgment" (Shedroff, 2000).
I try to offer a better and "livelier" experience for users by abolishing a static and showing a seeming "randomized" structure. It only seems to be randomized; there are rules, like grouping behavior, which the user can reveal by observing, interacting with, and navigating through structure. I try by using natural metaphors to give the user the possibility to use his experiences from the real world to interpret information. Because the user has to fall back on his "natural" experiences, I expect on one side that he can understand easier information and on the other side that he can experience digital information similar to information he receives in his natural environment. The aim to create experiences, which nature can offer, is high. Natural experiences are characterized by their variety, by their emotional quality, and by including the whole body and its senses. For instance, when I am observing animals, I hear their noises, I can smell them, I am afraid when they come too close to me, I am afraid when they are bigger than me, or I am thrilled when they become trusting. Observing and interacting with animals is a physical and sensual experience, which triggers many emotions in me. I cannot replace these experiences with my case studies.
But I hope, that the user can connect these natural experiences to my created animals, that he perceives them through the experiences he has made in the real world.

STRUCTURE, NAVIGATION, AND INTERACTIVITY AS A WHOLE

Navigation is commonly separated from the content, like on web sites. Navigating takes place through menus – a collection of links placed at a specific position. Designers want to label navigation elements to ensure minimal effort for users to find them. In my case studies, I abolish this separation between structure, navigation, and content. I unfold the information structure and use this visualization as the system navigation. The structure becomes navigation; navigation becomes interactivity with information. For instance, in the case study *Jellyfish* the structure of the encyclopedia is visualized by jellyfishes, the user navigates through and interacts with jellyfishes to obtain information. You cannot tell anymore which part is structure, or navigation, or interactivity; it is one whole.

We interact directly with other humans and animals, with our whole environment in the real world. This interactivity makes it possible for us to get to know it. How does it react on our behavior? Why does it behave in this way? How is its character? We have to interact with an animal to really understand it; it is an active exploration process. In my visualizations I try to provide an active exploration of information by abolishing the common separation between structure, navigation, and content. I offer the user the ability to interact directly with information. The user does not jump from one point to the next. Information is not visible at once; the user uncovers information step by step during an active process. As in real life, navigation and interactivity becomes the main information mediator. The process, the way to information is important. It can be compared to experiences I have made by watching a good movie. A movie leads me step by step to the final solution; it does not tell me the end in the first few minutes. My curiosity about how the story will end makes me continue watching. This is one reason why I offer this kind of navigation. The user should feel like getting more information about a subject. Navigation and interactivity should offer this experience. In real life, direct interactivity also establishes an emotional relationship with an animal. Granted, the user cannot establish the same emotional relationship with my digital animals as he can with real ones, but he gets the impression of dealing with something “living”.

CONCLUSION

THESIS PROCESS

At high school I visualized learning materials to support my own personal learning; later at my German university and today at the DMI I visualize data, to support the understanding of information for others. Information visualization is the leitmotif of my whole design career and has led me to my thesis topic. In the first year at DMI, I experimented with many elements, which were later parts of my thesis research.

In the first term, I developed *Bodymachine*, an application that does not use obvious natural metaphors but metaphoric transformation of the human body to visualize data. In the second term I developed *Jellyfish*, which was the conceptual starting point of my master topic. While working on this case study, I became curious. How can I use metaphors of natural form and behavior for information visualization? When it was time to define a thesis topic, I knew this area would be interesting for me to investigate further. I had the feeling that there is more behind natural metaphors, that it could offer methods to push the limits of visualizations. The more I engaged in natural metaphors the more I saw possibilities to use them for visualizations. In *Pattern Cards* I experimented with manipulations of natural structure to visualize information. *Natural Icons* was an investigation as to how static metaphors can indicate additional information. *The Lab* was a preparation for *Anymails* to test the perception of motion. Finally, all observations I made in previous case studies came together in *Anymails*.

One of the most important lessons I have learned is the value of experiments. I could not predict things like the effects of certain motions; I had to try them. Only by trial and error could I understand why and how we perceive and interpret forms, motions, and behaviors in a certain way. Trying, stopping, reflecting, changing and starting over became my process. It is somehow like cooking. When the soup does not taste good, you add or change something until you are satisfied. I have not reached the point, where I have investigated and understand everything. I feel as though I have just started and there is much more to uncover.

EMERGED THEORIES

HUMANIZATION

When animal-rights activists want to attract attention about an endangered species, they often humanize animals. For instance, this animal cares like you about its children; it also has feelings like you. This is a sensible method to explain behaviors and characteristics in an understandable way to the viewers, to address emotionally the viewer. It allows the viewer to identify himself with an animal; he is able to relate his experiences to the animal's experiences. Something unknown and abstract becomes something which he can understand. Designers can also use this method to make information more understandable for users. Natural metaphors humanize information; its attributes and conditions are visualized by behavior based on human behavioral patterns. For instance, information, which does not belong together, avoids each other like humans who do not like each other. The humanization enables the user to identify himself with information and thereby can better understand it. Information becomes less abstract; information is visualized by our connection to it.

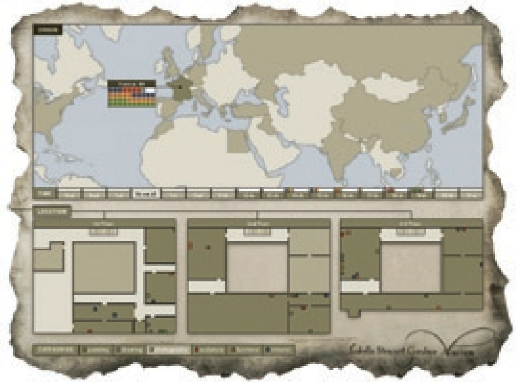
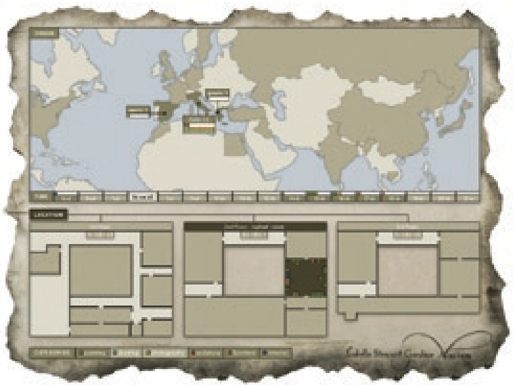
LIVING EXPERIENCE

In real life we communicate in a living way with something alive. We use our behavior to communicate like gestures and observe behaviors of others to interpret a situation. This enables us to perceive our environment as a living, constantly changing experience. Designers can use real-life experiences to offer users a living experience in the digital world, too. Natural metaphors can turn information into something living. User's experiences with "real" subjects are integrated in information visualization; he has to fall back on his experiences to interpret information. This is an opportunity to perceive information as a living experience because the user can connect digital animals to experiences and feelings, he has made with real animals. Through natural metaphors information can surprise him, can scare him, can delight him. It makes the user curious; he cannot predict everything.

PROCESS TO INFORMATION

In real life, information is often not visible at once, but rather becomes visible and interpretable during an inactive (observing) and active (acting and reacting) process. For instance, when I meet a stranger, I observe his behavior. Is he calm, shy, or nervous? Does his behavior change? Does he become more relaxed or anxious? How does he react to my behavior? Information about this person becomes visible for me step-by-step. Information is not a finished product but a consequence of a process in which I participate. Communicating with him and observing his behavior during the conversation enables me to assess his character, to understand him better. The way to information, the inactive and active process, is also significant for information visualization. It is not always the best way to mediate information by making it visible at once. Like a good conversation, it is important that information emerge. The user should have the opportunity to observe, to explore, to discover, to uncover, and to create information. When he participates in the process, he can understand information through his own behavior and reaction to his behavior.

OTHER
CASE STUDIES

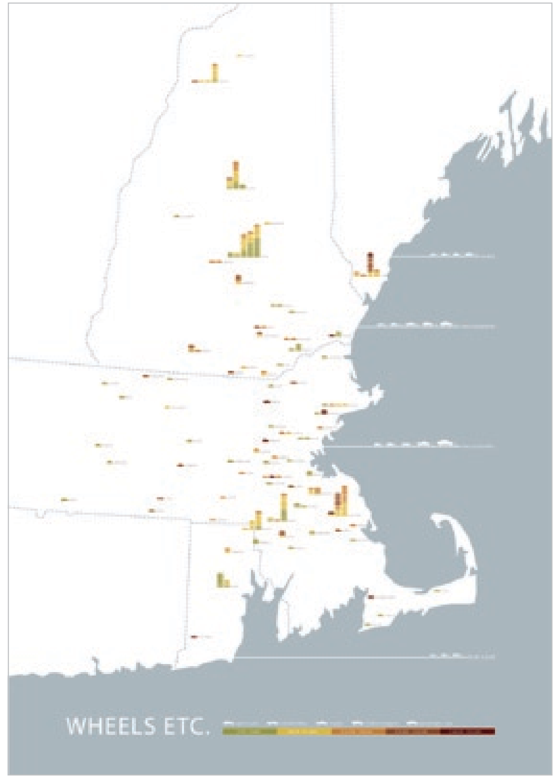





ISABELLA STEWART GARDNER MUSEUM

The case study was developed with the help of my advisor Prof. Brian Lucid in the class Information Architecture in Spring 2005. The assignment was to visualize the art collection of the Isabella Stewart Gardner Museum in Boston.

The project I developed displays quantitative data about each piece of art: its country or origin, its creation date, its current location inside the museum, and the kind of object. The user can filter information by these different attributes to find a particular group or piece of art. The screen is divided into four separate areas to show the different attributes of artwork: a world map to show the country of origin, a time bar to show the production date, outlines of museum galleries to show the current location, and a menu to show the category (furniture, drawing, painting, sculpture, ...). The attributes of artwork are shown by the placement of colored squares – which indicate categories – inside these visual areas.

The four attributes (category, location, time, and origin) become information filters to show or hide artwork. For instance, by selecting furniture of the filter category the following is visible: the distribution of all furniture in the museum (shown by squares located in the outline of galleries), the production dates of the furniture (shown by colored lines in the time bar), and the country of origin (shown by squares located on the world map). In this way, the user can recognize that a high quantity of furniture is from Italy, that most pieces were made in the 16th and 19th century, and that the pieces are evenly distributed in the museum.


WHEELS ETC.

WHEELS ETC.

The case study was developed with the help of my advisor Prof. Brian Lucid in the class Information Architecture in Spring 2005. The assignment was to visualize the contents of a magazine.

I chose *Wheels ETC.* – essentially a collection of classified advertisements of cars available in New England. I visualized the location, type, amount, and price range of the cars. I developed icons that represented the type of car and used color to represent the price range. The number of icons shows the amount of cars. Location is indicated through the placement of icons on a New England map. The viewer can quickly view where expensive or inexpensive cars are offered, where more or less cars are offered, and where particular types of cars are offered.

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