INTRODUCTION

In the environment in which we create our art, interactivity and the interface are very important concepts to consider - why and how people interact with the new medium (the digital, the web) and how the artist conveys her message in the most effective manner. Dinkla (1994) points out that, while in the first generation of interactive artists a story or metaphors often influenced the content of the work, the content of the current work is the interaction itself and that makes the design of the interface even more important.

THE DUALITY OF ART AND CARTOGRAPHY

When looking at the hyper-modern face of art, we must also be mindful of the origins of art, as this gives us a clue to where we are heading. In the beginning art was representational, in that it was the medium through which success at a hunt or a food source was recorded for future reference, by means of paintings on cave walls or stylistic engravings on stone. However, even in these earliest periods of prehistory, interactivity was an essential component to this art, and the shaman or medicine man of the tribe provided the data store. Songs, story-telling and dances, in which great events were re-enacted, provided the background information that placed the images in context and gave them meaning.

As man evolved and the environment became more complex (ie. the amount of data increased) it became necessary to represent data in an increasingly representational and stylistic manner. However, what appears to have happened is that the imagination inspired by record of the events diverged from the pure data, and so we had the divergence of two streams of information transfer - the artistic and imaginary versus the representational and factual. In this way art and cartography may have diverged, each following its own information transfer paradigm. The recording of data is reliant on certain methodologies for preventing decay, and so cartography became an extremely codified way of presenting data, even though the cartographer still dictated the way in which the data was to be interpreted. Art, on the other hand, having no constraints on maintaining any initial record of what was observed, diverged into a multiplicity of directions, one for each artist, a highly individualised form of visual and other stimulus which the artist wished to convey. As a result, no overall guide to the interpretation of such images, or modified data, was
available and interpretation became almost information-free in some cases, tending towards pure emotional content.

With the present overabundance of information, and our increasingly virtual and electronic world which is reducing all to digital bits, the original means of conveying the sense of the data from pictures, song and dance is being recreated by the new media - images, audio and interactivity. I stipulate that we are witnessing the convergence of the duality of art and cartography, and far from being just two isolated aspects of our daily lives, they are once again assuming the position of importance that they had for our distant ancestors, whose very existence depended on knowing what had been and what was to be, all the while giving texture and meaning to their present.

INTERFACE AND INTERACTIVITY

The most common complaints about interfacing and interactivity are that we are just clicking away, just selecting, with no creativity involved. We have no overview, cannot see where we have been and lose our way, our sense of place.

Manovich (2001) points out that new media does not tell stories but favours the database form (from the user’s point of view) and that the web is the ideal database - a collection of separate elements to which it is easy to add or insert new elements. Therefore, in general, creating a work in new media can be understood as the construction of an interface to a database. The problem arises with the fact that a database does not necessarily need a narrative to function. In new media, the database is given material existence - it is there - stored somewhere on a server. But the narrative is virtual. The narrative is constructed through the linking of elements of the database. It is what gives the user the experience, helps him to learn. What happens in most cases is that we experience one of two extremes - we either have an interface with a few buttons that will lead the user to data that is all of equal status (which will be very difficult to use - just think of Patchwork Girl (Jackson, 1995) or the interface will make a screen available that explicitly shows all the available choices. This shifts the psychological process from creation to selection. The medium asks the viewer to follow the structure of someone else’s thought process - the mental path of the new media designer - and therefore constrains the creative process of free association. Interaction is now the physical interaction between the user and the computer (clicking the button or using the mouse). Manovich (2001) stresses that when we are creating an interface or an interactive art piece the psychological interaction is still the most important. The psychological process of filling-in, hypothesis formation, recall and identification makes it interactive and gives it the virtuality. The buttons and mouse are just tools.

THE MAP AS INTERFACE

The concept of a map is being continually extended. Maps are no longer just pieces of paper that represent geographical information on a 2D surface. “The Hypermap are georeferenced multimedia systems that can structure individual multimedia components with respect to each other and the map.” (Kraak & van Driel, 1997) The map allows data sets to be explored whether they are nodes or photographs.

Manovich (2001) argues that the hyper linked Web is “in a way its own map - its own reality”. In her paper on the Design of Multimedia Mapping Products, Suzette Miller (1999) says: “The map enables users to access multimedia content relative to spatial location via map symbols that have been defined as hot spots. Maps are used as ‘Content Organisers’. They visually organise content using a spatial metaphor. In some cases multimedia content is designed to help the decoding and interpretation of maps, but in most cases maps are used to arrange content in an easily accessible manner.” Map-based access has also been used to arrange content that is not conventionally spatial in nature (Hodges & Sasnett, 1993). Map-based access is used relatively commonly as means of access in multimedia products and web-based sites.

If we make the assumption that an interface is essentially a map that creates a door to the data on the other side of the threshold, we can also look at the cartographic principles of the map as an interface, enhancing our understanding and ideas about the design of an interface.

THE PROPERTIES OF A MAP

A deeply ingrained concept in cartography is that abstraction is the ultimate goal when making a map and that the more abstract a map is, the better it works as a functional representation of reality. The purpose of cartography is nothing other than creating a representation of the world that works better than reality itself.

With new media and interactivity, cartography is evolving, driven by the same forces as other media, where huge amounts of information can easily be added to or linked to a site. Maps are now combining with other media (text, pictures, video, etc.) and
the assumption is made that this will lead to a more realistic picture of the world. When we are looking at a map that represents a specific geographical space, this might be true, but as soon as we use the map to visualise an abstract idea where we want the user to be creative and construct his own mental image, abstraction is still the most useful tool.

Not all maps are intended to represent the physical world. This is illustrated when looking at the difference between phenomenon representation and concept representation (MacEachren, 1994). A phenomenon representation is a representation of an aspect of the physical world. A concept representation is derived from a concept about reality.

A map is nonsequential. It displays every object to its user at the same time, but makes use of colour intensities, size differences and icons to show different layers of information. The importance of these layers will differ from user to user, but can be explored in any sequence.

A map shows different objects in relation to each other and therefore the user will always be able to find his way around no matter where he starts to explore. He can see where he has been and plan where to go next.

Maps provide a way of merging three fundamentally different categories of meaning, namely meanings about space, time and attributes in space-time (MacEachren, 1994).

The interactive map creates an environment for multiple interactions between the cartographer and the map-reader and the cartographic process can be extended with available technology to include a process where cartographers can get information back from the map. As the map- readers interact with the map, it can collect information and pass it back to the cartographer. In this way a record of where you have been and how your thought processes work is established.

MacEachren (1994) also points out that it is possible to isolate several connotative functions of maps. Maps imply accuracy and are believed by people, because they think they are free from error. Maps are also thought to be unbiased and to have integrity, especially in the case of scientific maps.

**DESIGN PRINCIPLES OF CARTOGRAPHY**

The most important aspects of cartographic design are the purpose of the map as well as the abilities and knowledge of the user. There are two specific visualisation strategies - mapping for public communication, which fits more into the traditional realm of cartography, and mapping to stimulate visual thinking. Many maps are not produced as final products, but as intermediate tools to support the user in his work dealing with geospatial data. They offer the user the ability to instantaneously change the appearance of a map. Interaction with the map will stimulate the user's thinking and will add new functionality to the map. As well as communicating, it will prompt thinking and decision-making.

Map use can be conceptualised as a three-dimensional space. This space is defined by three continua (MacEachren, 1994)

The three dimensions of MacEachren’s model are:

- map use that is private, where an individual generates a map for its own needs, to public, where previously prepared maps are made available to a large audience
- map use that is directed towards revealing unknowns, where the user may begin with only the general goal of looking for something “interesting”, versus presenting knowns where the user is attempting to access particular geospatial information
- map use that has high human-map interaction where the user can manipulate the map in substantive ways versus low interaction where the user has limited ability to change the presentation.

**Movement/animation**

Animation has brought with it possibilities for visualisation that cartographers have been needing for centuries. In digital cartography the user's viewing environment is, by default, interactive and allows them to use and view Hägerstrand's Space-Time-Cube from any direction. Data can be extracted from a database by software that will give the user full flexibility to

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1 At the end of the sixties Hägerstrand introduced a space-time model which included features such as a Space-Time-Path and a Space-Time-Prism. This model can be seen as one of the pioneering ideas in the study of temporal geography. The Space-Time-Cube was the most prominent element in visualisation and consists of a cube with geography represented along the x- and y- axes (which form the base) and time being represented along the z-axis (height)
view, query and manipulate the data in a Space-Time-Cube. Slider planes can be moved along each of the axes to select or highlight a period in time or a location in place. World time can also be changed for event time and so a very creative process develops and this alternative perspective on the data will stimulate the mind to create new ideas and solve problems. Kraak (2003) quotes Finke, R.A., Ward, T.B. & Smith, S.M., (1992), saying “...creative discoveries, in both art and science, often occur in unusual situations, where one is forced to think unconventionally”.

Movement or animation in a map can, however, be so overwhelming that the more subtle information which is displayed by using variables such as texture, colour and shape can get lost. MacEachren (1994) addressed the need in dynamic cartography for space-time dimensionality by expanding Bertin’s\(^2\) visual variable taxonomy to include:

- Display date - the time at which some display change is initiated
- Duration - the length of time nothing changes at the display
- Frequency - the analogue of duration. Each can be defined in terms of the other
- Order - the sequence of frames or scenes
- Rate of change - the difference in magnitude of change or unit time for each of a sequence of frames or scenes
- Synchronisation - synchronisation (phase correspondence) refers to the temporal correspondence of two or more time series (Kraak & Klomp, 2003)

By using these variables to control movement, effective communication and prompting for a creative response from the viewer is possible.

Although animation used in maps makes extensive use of the variables’ order and duration to create some kind of narrative, the main aim of animation in cartography is to help the viewer build up an understanding of the data. Kraak & Klomp (2003) adapt Dransch’s classification of nontemporal animations (Dransch, 1993) to three types of animation that are used in cartography, namely:

- Temporal animations, in which time series show the change of spatial patterns with time.
- Non-temporal animations, in which successive build-up leads the viewer through a theme, to help understand spatial and contextual coherence. Adding subsequent map layers would be an example.
- Changing representations where a data set is shown in different graphic representations to provide the viewer with a comprehensive impression of the same data set.

The visualisation process is always influenced by several factors such as scale, the problem of generalisation and whether we are dealing with topographic or thematic data. With the web and interactivity a much more important design question comes to the fore because the user can now select the data he wants. This is the question of whether the data to be represented are qualitative - having no ranking, only a difference in type (ie tree or dam), or quantitative. In other words, whether it can be classified and ranked (small dams, big dams, lakes). Giving the user a choice to decide for himself is a good option, but in doing so the cartographer has to let go of full control of the visualisation of his data. As the process of combining different data type layers can stimulate creativity, so can this decision about the representation of data.

**Elements of design**

Humans are good at interpreting visual data, but conventions are still necessary to convey the map's message.

There are four geographic data types, namely point, line, area and quantity, that are represented on maps by means of symbols. Point symbols may represent location only or they could also represent a value or measurement. Line symbols have an extra dimension, length, and show linear geographical features such as rivers, as well as non-physical linear features like boundaries. Area symbols are two-dimensional and depict features that occur within a bounded spatial unit e.g. forests and lakes. Quantity can be represented by varying sizes of point symbols, conveying relative variation. Because pictorial symbols resemble characteristics of the feature they represent they are easy for the map user to memorise, but care must be taken that the symbols or signs are not misinterpreted. This happens very easily, because people add different values or meanings to symbols. MacEachren (1994) says: “For quantitative depiction on maps, meaning is often defined on the basis of some strict functional relationship between the graphic variable sets and the data sets being represented, for example the size of graduated circles is made proportional to magnitude of data; therefore a circle twice as big as another is interpreted to mean that the entity to which it is linked has twice the magnitude of some attribute.”

\(^2\) Basic point, line and area symbols are modified in different ways in order to communicate different types of information. The ways in which these modifications take place adhere to cognitive principles and accumulated experience of applications. The nature of these modifications was first explored by Bertin in 1967.
Basic symbols are modified in different ways to communicate different types of information. Bertin first explored the nature of these modifications. The size, orientation, use of colour, value and saturation of colour, shape and arrangement of the symbol as well as texture are variables that cartographers use to best communicate the meaning of the data.

Apart from using web-safe colours and not using to many different colour hues together, there are an array of factors that should be taken into consideration, for example that different colours and different colour intensities have different meanings. MacEachren (1994) states: “ordered colour or values ‘mean rank ordered data to map readers’ and that dark values ‘mean’ more while light values ‘mean’ less.” “changing the surrounding background of a map displayed on a computer monitor can change the apparent meaning of colour value ranges applied to choropleth maps.”

Other very important considerations in cartography are the use of scale and layers to make information more accessible and understandable. At a certain scale some objects will be left out or simplified to improve the overall legibility of the map. In principle a web map has no fixed scale since it can be enlarged or reduced by zooming. However, there are different zoom strategies that web cartographers can use. Static zooming, where a static image is enlarged, static stepped-zooming where a series of maps of the same area are available and the software chooses the best one for the scale, and dynamic zooming where there is a direct link between a database and the map. The use of layers in GIS and cartography is a concept where different data types are stored separately. The cartographer or map user can then decide which types of data he wants to use together and switch the visibility of the unnecessary information off.

The map as an interface to a database works well only when the design principles for media are adhered to:

The effective interaction between user and product is key to learning and communicating, which means that the design of a user friendly and effective interface is critical to the success of the multimedia cartographic product, regardless of the form it takes. There is a significant difference between expert and novice users. They will interact with the data in very different ways. The process that the user has to go through as well as the concepts that he must grasp are much more important than stimulus, which was previously the main area of research in cartographic communication. Simplicity is a critical element, from a user’s perspective. Buziek (1999) summarised the concepts of Ballstaedt (1990) of audiovisual integration, where two fundamental principles could be derived for the design and use of dynamic elements:

- Investigate the user's attention and whether it has to be called, or not;
- Support concepts of knowledge-construction in order to achieve efficient communication.

He then suggested the following rules with respect to multimedia presentations:

- Investigate the target group in order to detect user's focus of interest.
- Use eye-catching effects to call, control and increase the user's attention.
- Fit the design of the multimedia elements according to the user's prior knowledge and the concepts of audio-visual integration.
- Reinforce important information through repetition, explanation, and double encoding.
- Be aware of mental processing time.
- Avoid audio-visual overloads by limitation of information-carrying items.

These design principles have long been utilised in the areas of visual displays such as shop window displays and museum exhibits, where the user or observer’s attention must be caught and held for a period of at least 15 seconds in order to assess the information presented to the short term store (Kluwe, 1994). The simplicity of the display is also essential, bearing in mind that the short term store's capacity is limited to 7±2 items if the user is concentrating (Miller, 1956) and 4±2 if not (Carroll, 1982).

In her paper “Theoretical issues in Multimedia Cartography”, Dransch (1999) presented a table that gave an overview of the functions that media may have in cartographic multimedia presentations. As we are looking at the map as an interface helping us to visualise the structure of the data in cyberspace (not georeferenced), and we want the viewer to make constructive and creative use of the site, let us examine what she has to say about the creation of mental models.

Under the Didactic Approach in “Function of Media in Knowledge Generation” she has media as a function of construction. “This type of media should help the user to create complex mental models. Mental models are constructions of pictorial and propositional knowledge about information units and their relationships. Media for this purpose have to inform about concepts,
elements and their relations. The creation of mental models is highly influenced by applied media. Pictures or realistic presentations are not suitable in this context. This function requires abstract media that show prepared information such as text, maps, diagrams, graphs and abstract animations or formal sound. Media for this purpose must initially present an overview of the complete information structure and subsequently inform about detail.”

It is very important to understand that any arbitrary combination of media cannot be labelled as a multimedia system and, that only the combination of multimedia techniques, applications, contents and functionality can define actual multimedia systems. A multimedia system’s media must be applied in such a way as to gain the effects of synergy.

CASE STUDIES

Maps are being used as website interfaces very successfully. In this section I will describe and comment on the use of maps as interfaces on three sites. The particular areas of interest are firstly, what type of communication or interactivity do they support? Do they just support public communication or do they stimulate visual thinking? Another important factor is the use of abstraction to enhance communication.

1) The Theban mapping project  [http://www.thebanmappingproject.com](http://www.thebanmappingproject.com) is a classic example of a map being used to organise a database and not necessarily being a product of a database itself. Here we find a lot of information about excavations, places that have been explored and artifacts that have been found. Because everything has a specific georeference, the most logical way to help the visitor to the site orientate himself is by using a map as interface to the data.

On entering the site one is presented with an easily recognisable map of the flood plains bordering the Nile River and can see areas of interest highlighted by rectangles. These indicate that the data is georeferenced and “real” and that the visitor is going to enter and explore specific areas. The automatic zoom created by Flash that takes one to the interactive site map unfortunately grabs the control that the visitor might have thought he had, right out of his hands and may be unnecessary and time consuming.

The idea of presenting a site map by means of a plan view with the photograph of the valley on the right is good since it shows reality and then simplifies it to a very abstract form. This makes it easier to build a mental picture of the area and places when one looks at the photographs and video clips. Unfortunately it is not a hundred percent effective because it takes a while to mentally place the map into the photograph. The addition of a thin coloured outline of the specific area on the photograph or contour values on the shaded elevation around the map would have helped the visitor to orientate himself much faster. Using a photograph of an area or chamber with an abstract schematic representation thereof is a good idea which is employed throughout the site. Information is thus double encoded, a attempt to construct lasting knowledge.

Two levels of interactivity are found in this site. The first-time visitor will most probably only see the main map in the interactive *Atlas of the Kings*, click on the map and click on the video's to get to the information. In other words, this “click”-- interactivity only leads to public communication. The more interested and educated user will reach the second level of interactivity which is situated on the “description” and “map & plans” buttons in the upper right corner. Here one gets detailed plans of the burial chambers and by using the sliders and measurement tools at the bottom the user can zoom into a specific area of interest and determine the exact size, angle and direction of the chambers. Unfortunately it takes a while to come to grips with the use of the interactive tools because the use of pictorial or iconic symbols can lead to misinterpretation.

It takes a bit of effort, but the interested person will soon be stimulated to start interacting with the data, as the interface creates an environment that stimulates visual thinking.

2) The introduction to the [Skyscraper Museum](http://www.skyscraper.org/WEB_PROJECTS/projects.htm) says the following: “The Visual Index to the Virtual Archive is an innovative visually-based interface that uses a 3-D computer model of Manhattan as a click-on map, allowing Web visitors to view the city, present and past, and to access the Museum's collection through an on-line, searchable database. The idea of a visual index to the collection recognizes the importance of graphic representation in both the medium of the web site and in the way that visitors, virtual or actual, come to understand and comprehend a city through it's geography and landmarks”

The core of the project is to explore tall buildings for a variety of reasons stretching from design to investment. Because the site can be entered from and utilised in different ways and order it stimulates the viewer and allows people with different interests to explore the buildings whether they have a specific question in mind or not. The Down Town New York Web Walk consist of four walking tours.
Upon entry to the Web Walk site one is presented with a birds-eye view of the area consisting of the coastline, roads and buildings. This helps the user to immediately orientate himself by using the landmarks known to him. The four walks are colour coded while the rest of the buildings remain white. Although each walk has a different colour, the intensities are the same, except for the colour of the Twin Towers, which are darker and more transparent, resulting in a ghost-like appearance. The names of the different walks are "flagged" and only come up when the cursor enters the area, which keeps the map clear and simple. The only improvement that can be suggested here is a change in the lime green colour choice of the City Hall walk. A darker colour would have made the name much more legible.

The digital interactivity on this part of the site is not much more than getting to information and photographs of the various buildings, but the dates of completion enable the user to begin to get an idea of how and at what times the city developed. The facts about and reasons for the buildings stimulates the user to interpret the data and come to conclusions, such as during which period the economy was booming or bad, reminding us of what Manovich says interactivity really is.

In hindsight, using a map as an interface to get information about buildings seems like a very natural option, but the information could just as well have been made available via a pop up menu with a list of building names, areas or dates. However, this would not have lead to the creation of the mental picture that the visitor to this site now forms.

Although this part of the site makes use of very realistic, 3-D representations of buildings, the simplifications and abstraction as far as the use of colour, topographic data, names and relief are concerned makes it understandable and easy to orientate and navigate to the underlying information. This is about specific georeferenced buildings in very specific places. Creating ones own mental model about the data that lies within the information about these buildings happens when one start using the next part of the site.

The Manhattan Time formation is the most interactive part of the site for a variety of reasons. The designer extended the New York City map from the x-y plane to include a time or z-axis (Hägerstrand’s Space-Time-Cube) with each year representing 1000 feet. This gives an interactive history of the building economy. It offers the user a choice of viewing it from different directions and there is a Flash generated fly-through which can be manipulated frame by frame.

Different types of information are grouped in layers and show the dynamic relationships between the geological formations, landfill, settlement patterns and other urban information. This very idea comes straight from cartographic or GIS thinking and gets used as soon as the amount of data becomes too great to interpret sensibly when viewed together. It is far better to allow the user the choice of the information he wants to see together to make his own interpretation of the data.

This is a good example of converging media, where design, animation, cartography and GIS comes together to create an interface, as in the maps of old which contained not just facts, but also art which stimulated the “traveller” to dream and wonder about the possibilities lurking in the blank or data-poor areas of the map - Here Be Dragons!

The last site that I want to look at differs from the previous two in that it goes to great lengths to make sure that the data does not get connected to a specific georeferenced space.

3) Paris: Invisible City http://www.ensmp.fr/~latour/virtual/index.html#. is not a site about the Paris that everybody knows or associates with. Bruno Latour wants to show his viewers a different or deeper city from a different perspective. The site is divided up in four main areas and in each of these there is a map that takes the visitor to a world consisting of photographic enquiry and social theory put together in a very philosophical way. Ryan Griffiths commented on Rhizome, “Paris, for Latour, is not tracked by static, isolated images, but rather by the traces of the transitory and interdependent. The city is visualized through the social and technical networks that give meaning to spaces” (Griffiths, 2004, http://www.rhizome.org/).

The “map” that he uses as an interface is very abstract and immediately conveys the message that this is not so much about places than spaces. It shows a route with different options that you can explore from any direction. (A tour guide that gives you options and directions, but does not tell you where to go). This imagery of a virtual Metro and the content encourages a very creative response from the visitor. You have to take part and explore, make mental connections and philosophise on what is presented to really experience this invisible city. By involving the visitors in such a way, they start to experience the sensation of their travels through the invisible city.

The nonsequentiality of the map contributes to the successful use of it as a interface in this site, because it allows for a non-linear process of discovery which is apparently very important to Latour. Having the map with the highlighted icon next to
you while you explore is very reassuring, but it would have been helpful if the links to where you have already been also showed up in some shade of the colour used to help with orientation.

In each of these sites video's or photographs are used to convey information to the user, but the user can only really start interacting with the information once he is presented with a more abstract representation which helps him to create a mental model of the data and how to go about using it meaningfully.

CONCLUSION

Although we are an information society, where data and information are equated to power, there is such an overload of data around us that it is easy to add that extra bit of information. Just like the cartographer who has always had to make careful choices about the type and amount of data that he was going to represent on his map, today's multimedia artist has to be very careful not to bombard the viewer or user with data. By applying cartographic principles they can create a framework to work from that will help them to create their interactive artwork.

"An artist is now much more seen as a connector of things, a person who scans the enormous field of possible places for artistic attention and says, "what I am going to do is draw your attention to this sequence of things" (Eno, 1995).

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CARTOGRAPHIC DESIGN PRINCIPLES IN INTERACTIVE MULTIMEDIA

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