Informative Art: Using Amplified Artworks as Information Displays

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Informative art is computer augmented, or amplified, works of art that not only are aesthetical objects but also information displays, in as much as they dynamically reflect information about their environment. Informative art can be seen as a kind of *slow technology*, i.e. a technology that promotes moments of concentration and reflection. Our aim is to present the design space of informative art. We do so by discussing its properties and possibilities in relation to work on information visualisation, novel information display strategies, as well as art. A number of examples based on different kinds of mapping relations between information and the properties of the composition of an artwork are described.

Keywords

Art, design, augmented and amplified reality, information visualisation, ubiquitous computing.

Introduction

In hotel rooms, offices and other public spaces, as well as in our homes, pictures, posters, textiles etc. often can be seen as part of a designed environment rather than as solitary art objects. Although the distinction between design/decoration and artworks is subtle, it is clear that the pictures, posters etc. in these cases are integrated parts of a given environment.

An artwork is also a part of the environment in the sense that it can act as an information carrier giving hints about different properties of the place where they are located. The pictures, posters and other artworks in an office or in someone's home can give a visitor information about the local office culture or its owner's

aesthetical preferences. Having a certain poster clearly visible to everyone entering an office, can be a way of making a statement.

In this paper we describe how other kinds of information can be mapped onto the design surface as well, making pieces of art more explicitly reflect aspects of its environment. Our aim is to present the design space of *informative art*, by discussing its properties and possibilities primarily in relation to work on interaction and information design. We will also illustrate what informative art might be like in practice, using a number of examples.

Background

There are at least two reasons for complementing the desktop PC display with other techniques of providing information from the digital realm. First, the screen estate of an ordinary display is limited and already crowded with more information than most users can gain overview of. Second, since users are not always located at their desks, and since what information is relevant is highly dependent on where and when a person is doing something, users need other ways of obtaining the desired information. The concept of ubiquitous computing [28] was introduced as a way of achieving both of these aims. As computers become available anywhere anytime, they might become a less intrusive part of our lives that poses fewer constraints on how we structure our activities, compared to the present situation. That is, if the problems associated with having information technology available everywhere all the time can be solved. It seems that much of the design strategies developed for the ordinary PC will not hold for ubiquitous computing.

One of the reasons is that the PC is designed to be one of the most important "things" to its user, being in focus and continuously attended to when in use. This might work when we have one or maybe a few devices around, but if our environment would be full of computers – as the ubiquitous computing scenario implies – constantly calling for our attention, it soon would become intolerable. Thus, it has been argued that in order to achieve the benefits of ubiquitous computing novel ways of designing information technology that can reside in the periphery of our attention, will have to be developed [29].

Information displays of various sizes placed at a variety of locations have been a part of the ubiquitous computing paradigm since the very start [27]. More recently, other media and display strategies have been explored that are more radically different from how information is presented on an ordinary PC, e.g., the *ambient displays* created by Wisneski et al [30] and Rodenstein [22], *TouchCounters* [31], *Information Percolator* [10], and abstract information displays such as [18]. With

Figure 1: Picture showing three pieces of informative art on display at our lab.

ambient media the goal has been to integrate information displays with architectural space, often in the form of more or less ”tangible” presentations [12].

This research constitutes an important part of the background of the work presented here. However, while the work exemplified above has resulted in novel artefacts that act as displays, our aim has been to augment a traditional notion of art objects, turning the given type of design surface into an abstract information display. Aesthetics and design methods are in focus, not the development of new display techniques (cf. [3,4]).

Informative Art

With *informative art*, we refer to pieces of art that dynamically reflect, and therefore in some ways represent, information. Since this might describe almost any piece of art, given a suitable definition of ‘information’, it needs to be made more precise. The concept of informative art rests on a combination of the idea of using artworks to convey information, the way this was described in the introduction, with that of exploring how various objects and surfaces in physical space can be used to represent digital information.

Informative art focuses on how traditional art objects, like paintings and posters, can be augmented, or *amplified* [7], and made to display information. These amplified art objects will act as abstract information displays in the sense that the relationship between information and display surface will be a mapping between design structure and information structure rather than a effective presentation of information content. Adding a layer of information representation to an artwork can be made in several different ways. The strategy employed most commonly in the examples presented here is to map parts or properties of the composition to different sources of information, and have the composition changed over time according to the dynamics of the information.

Besides the fact that pieces of art already are used to convey information about different aspects of an environment, other properties such as placement make them suitable as information displays. The kind of artworks we are interested in amplifying, usually reside in the public spaces of an office or elsewhere where people passing by easily can take a look at them. Information displays placed at such locations have the advantage of not competing for attention with other applications, as would have been the case with yet another window on the personal computer display. Further, the information presented in informative art as described here, is not usually related to a specific person, but to a group of people or to a place. This makes it less relevant to have the information accessible on a personal computer, but more so in places where people move around in order to get a sense of what is going on. Below, we discuss some of the properties of informative art in relation to other work.

Information Visualisation

The purpose of informative art stands in contrast to using concepts and techniques developed in art to, for instance, improve application usability [2], to make more dense information visualisations possible by means of using many different layers of ”brushstrokes” [14], or the seemingly more accidental pieces of art that might be the results of various visualisation techniques, such as *TreeMaps* [13].

While these and other information visualisation techniques certainly can be said to have aesthetical values, they address the problem of how to use visualisation to create an efficient and useful tool for information exploration. Informative art, on the other hand, is more about how layers of information can be added to a certain structure or composition. This is also the reason for calling it ”informative *art*”, and not ”artistic or decorative information”. Given the importance of aesthetical considerations, informative art is related to the use of computational media in design and fine arts [16,23] (see also research groups such as [1]).

Awareness

A number of applications have been developed that support people's 'awareness' about different aspects of their environment. Especially support for spontaneous or "informal" communication among the members of a geographically distributed group by means of providing information about "what is going on" or "who is around" have been explored (cf. [5]). The rationale for such systems is that when people are co-located, physical space provides them with a number of cues, such as the sounds of people moving around or the light coming out of an office window, that seem to be of importance when engaging in spontaneous conversations. Systems more similar to the prototypes described here include for instance: *VisualWho* [6], which visualises the actions of communities on the www; *Chat Circles* [26], a system designed to enrich the virtual environment of online chat; and *AROMA* [18], a system that supports awareness of presence in a more abstract fashion.

Instead of making information about events taking place in physical space available in a virtual counterpart or by other means trying to build a richer context in a virtual social space, our aim has been to make otherwise invisible information available in the physical environment. Unlike conversations in the corridor, communication by means of for instance e-mail, documents, web pages etc., is invisible to everyone but the sender and receiver. By presenting cues about the such communication taking place at an office, we aim to provide a complement to the information already available (cf. the *Dangling String* [29]). The main purpose with the work presented here is not, however, to support informal communication, but to make the environment present information about the events taking place in it.

Designing for the Periphery

In many of the systems and displays discussed above, there has been a conscious effort in designing for the "periphery", i.e., to make the systems provide background information that does not continuously force the user to actively attend to it. In this project, we have also aimed at making the surface of the display objects non-obtrusive. This has partly been done by placing the display objects at locations where they do not interfere with too many other sources of information. However, the technology involved is also "calm" in the sense of a traditional art object: it is something we intentionally look at for moments of reflection; something we concentrate on for moments of mental rest.

The notion of peripheral attention can also be problematic. In the case of Muzak™ [17] ”art” is used as a background technology to manipulate and affect people in certain ways, e.g., to move faster or slower through a certain area, by presenting information designed to be perceived unconsciously. This is not the purpose with the work presented here. Information is ”hidden” in the sense that it is embedded in pieces of art, but not in the sense that it is designed to be unconsciously (or *subliminally*) perceived. For instance, the changes of a certain shape in a picture might reflect changes in outdoor temperature, but this is a fact about the dynamics of the artwork that people may or may not pay any attention to, even if they find the picture as such interesting. Further, the aim with the prototypes described here is not to reduce cognitive load in terms of less demanding or more peripherally perceived displays, the way it has been argued that for instance ambient displays might help reduce information overload [30].

Amplifying Reality

With *amplified reality* we mean the enhancement of expression or functionality of artefacts using technology [7]. The canonical example is how audio technology such as microphones, amplifiers and loudspeakers are used to amplify the expression (e.g. loudness), or functionality (e.g. the use of feedback and distortion), of musical instruments. The use of, for instance, the electric guitar in rock music clearly illustrates how such amplification can increase the possibilities of expression.

In contrast to some *augmented reality* systems that use personal technologies such as goggles or headphones to superimpose digital information onto the real world, amplified reality is about the *public* presence of the physical artefacts themselves. In other words, if a personal wearable VR-system made up of head-up displays, earphones etc. enhances the *impressions* of the real world by adding graphics, sound etc., amplified reality is about enhancing the *expressions* of the real-world objects themselves using primarily embedded technology.

Amplified Artworks

The project described in this paper is an instance of amplified reality in as much as it is an attempt to make otherwise invisible information visible using amplified ”art” objects as abstract information displays. Thus we attempt to pick up hidden information, like information about local digital communication, amplify it and present it through a public media.

By an amplified art object we simply mean a technological strengthening of a traditional notion of an art object, like a painting etc., and not an enhancement of the aesthetical expression *per se*. It might be argued that this is in fact the opposite of a strengthening, at least from an aesthetical point of view, but it is a technological strengthening of the surface in the sense that we, for instance, may work with a dynamical composition that changes its appearance over time. It is clear that this mainly is a conceptual matter since the work methods are completely different from traditional painting.

The conceptual reference to a traditional notion of an art object is of basic importance here since this reference determines the intended functionality of the amplified art objects, i.e., as objects in the given environment, they are nothing but ”paintings” functioning as a kind of information display. Obviously there are clear connections here with a long tradition of investigating form and material in experimental art and design (cf. [16,23]). Curiously enough the systematic aesthetics of information technology design seem until recently, e.g. [8,9], to have been rather neglected area.

Examples

In order to explore the concept of informative art, we have developed a number of prototypes that use different kinds of mappings between the dynamics of the *information* to be reflected and the composition of an artwork.

Information

The examples described in this paper are all, more or less, based on information stemming from digital communication. There are, however, a number of other sources of information that might be of interest as well. For instance, the structure of many buildings makes it quite difficult to get an overview of the activities taking place. If there are large open spaces one might see where people are moving, but otherwise information such as that many people seem to be heading for a certain lecture hall thus indicating an upcoming talk or session, is hard to obtain. Information about such more or less visible events in physical space might therefore be as relevant to the design of informative art as the occurrence of digital communication, given the purpose of amplifying otherwise unavailable information.

One possible source of information would be to use photocells placed adjacent to ”important” doors connecting different areas, e.g., the door to an office corridor, in order to obtain information about approximately how many people are passing by. Such an information source would still be rather abstract since no

information about whom, why, or even in what direction people are moving, will be available. Still it would be an indication of activity at that location. Another example would be to use a technology similar to the ones we have used in order to support local interaction (i.e., short-range radio transceivers that enable devices to ”know” what other devices are in the vicinity [20]) in order to make it possible for a work of informative art to obtain information about how many people are present in its near surroundings and change its composition accordingly. Such a mapping would also be a kind of abstract representation of activity at the location of the artwork.

Further, in some of the examples described above, time is used as a variable that is mapped to the composition. Other such general sources that might be or relevance includes light sensors to obtain the amount of daylight outside, thermometers for indoor and outdoor temperature etc. Thus, as there are a vast range of information sources that can be used in informative art, and since it is the different ways of mapping information to a composition that are the main focus in this paper, the information in the example below should be seen as illustrations that can be substituted rather easily for other kinds of information.

E-mail and Website Traffic

Every time an e-mail passes through a mail server, information about the mail is stored in the system log. What kind information is stored varies between different kinds of mail servers, but typically each row in the log file at least contains information about sender/receiver, what time the mail passed through the server, and the size of the mail. Similar to the e-mail servers, most web servers store their traffic in a log file. The information on each row in such a log file usually consists of what document was requested, when it was requested and who (i.e. what IP-number) requested it. To obtain the parts of this information that are required by the applications that perform the visualisations, we implemented a server application in Java, that parses the content of the log files, extracts the relevant information and finally sends it to the client(s) connected to it.

Compositions Using Colour Fields

Since many compositions make use of elements or objects with properties such as size, shape and colour, they present a number of possibilities of mapping external information onto the composition.

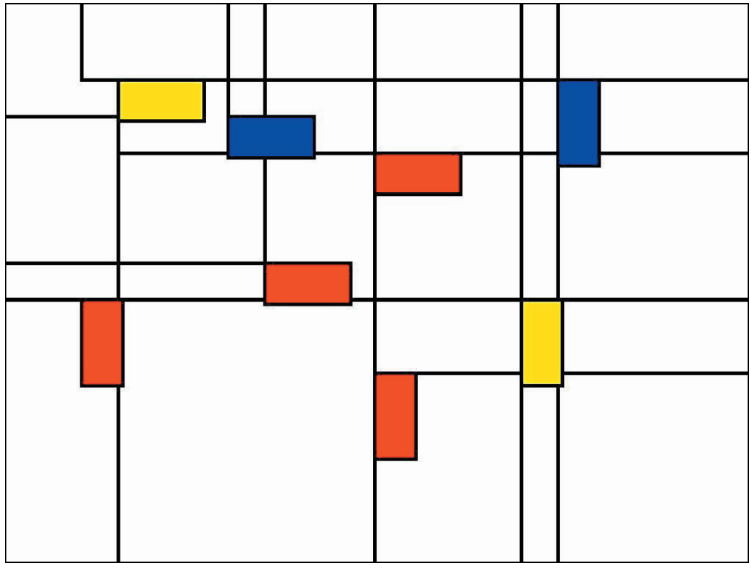

Figure 2: A Mondrianesque composition when initiated.

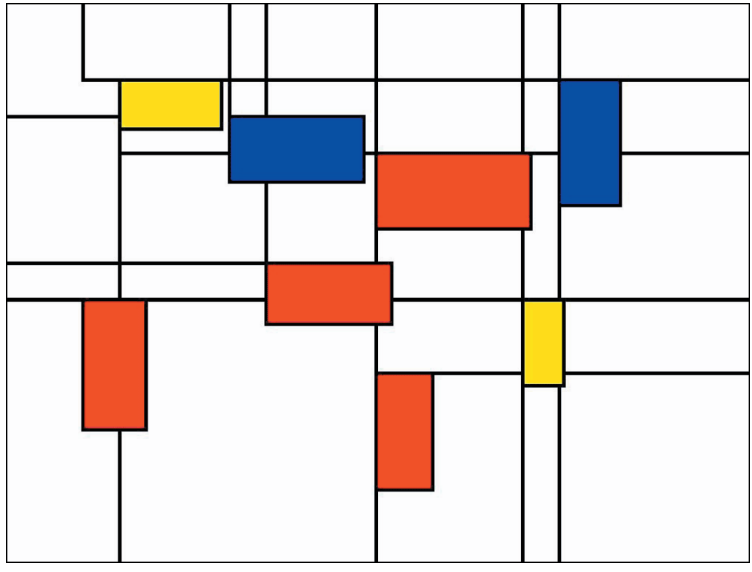

Figure 3: The same composition (fig. 2) when changed according to the e-mail traffic.

De Stijlistic Dynamics

Looking for inspiration for the visualisations we soon came to think of the compositions of the Dutch artist Piet Mondrian, which are based on rectangular colour fields together with black lines. Mapping information into such a composition can be done in dozens of ways. We have chosen to do a fairly straightforward mapping, where each colour field represents the e-mail traffic associated with one person (fig. 2). Whenever a person sends or receives an e-mail, the area of the field she is represented by is increased. Conversely, if someone is not involved in any e-mail communication for a period of time, the area of her field is decreased (cf. fig. 2and fig. 3)

Every time the system starts up, a new ”painting” is generated. To keep a certain structure of the compositions, each field is placed in the same place every time. The appearance of the fields, however, can vary in both shape and colour.

There are three possible shapes for the fields: quadratic, standing rectangular and lying rectangular. We have chosen to use the same colours as Mondrian did for his compositions, namely red, blue, yellow and black.

Other features of the composition, such as shape and colour of the fields, or even the lines between the fields, could also be employed for mapping information into the visualisation. In order to make the visualisations as ”Mondrianesque” as possible, we have chosen not to employ other colours than the ones he normally used, since varying these too much would probably steer the overall impression away from Mondrian. However, the compositions generated only have a superficial relationship to Mondrians paintings. This was also our intention, since the aim only is to make spectators associate the composition with Mondrians paintings.

A Klein Clock

The inspiration in this example comes from the *monochromes* created by the french artist Yves Klein. A monochrome is a painting using one colour – like the blue colour in Klein's late monochromes, referred to as International Klein Blue.

Let (a,b,c) be the RGB code for a given colour, i.e. the colour of a ”monochrome”. We will think of the three coordinates as abstract representations of the information properties ”mass”, ”growth” and ”flow”. As an example, one interpretation of these properties might be: ”mass” as number of e-mail, ”growth” as a ratio between the number of e-mail at a short late period of the given period and the number of e-mail at an initial period of the given period, and ”flow” as a ratio between the number of incoming and outgoing e-mail.

Figure 4: A Klein Clock Example

If we measure the e-mail traffic over a period of time – say the morning hours one day – with respect to some concrete interpretation of mass, growth and flow we obtain an objective information measure that can, using a suitable coding schema, be numerically coded as the RGB code of a sort of reference monochrome (a,b,c). We may now use this reference monochrome (a,b,c) as the basis for a structure of abstract colour symmetries in the sense that: (a_1,b_1,c_1) and (a_2,b_2,c_2) are symmetrical relative to (a,b,c) in case

$$(a_1,b_1,c_1) + (a_2,b_2,c_2) = (a_1+a_2,b_1+b_2,c_1+c_2) = (a,b,c)$$

Starting off with this, we can let the clock tick by adding RGB-codes modulo (a,b,c):

$$(a_3,b_3,c_3)=(a_1+a_2 \text{mod}(a),b_1+b_2 \text{mod}(b), c_1+c_2 \text{mod}(c)),$$

on the basis of given initial codes (a_1,b_1,c_1) and (a_2,b_2,c_2).

These initial colour codes can be chosen as predictions, as descriptions of an ideal state of affairs or as measures of past information activities. In this way distinctions like objective-subjective and presence-past etc. can be introduced.

The clock is divided in two fields (fig. 4). In the left field the colour of the objectivity/presence measure is present as a static reference and the structure generated by the two initial subjectivity/past colours is ticking in the right field. Each code (a_n,b_n,c_n) for a colour that is displayed in the right field is the sum – modulo

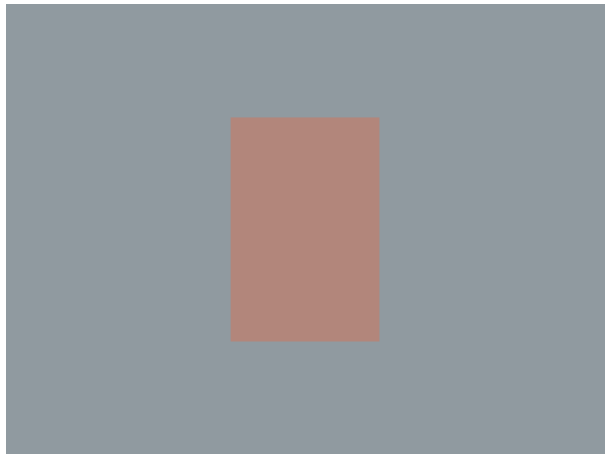

Figure 5: A clock displaying the flow of "objective" and "subjective" time.

(a,b,c) – of two preceding codes (a_{n-1},b_{n-1},c_{n-1}) and (a_{n-2},b_{n-2},c_{n-2}). The rate of ticking, that is the time each colour is displayed in the right field of the clock, is a function of the two immediate preceding codes, e.g.: (C + 10 * (x + y +z)), where C is a constant and (x,y,z) is the colour to be displayed in the right field. Each coordinate will have its own rate of ticking.

Intuitively the clock is ticking towards an ideal situation when the colour displayed in the left and right fields coincide. On its way towards this ideal state the clock will display different time structures of colours such as various cycles of repetitions etc. These structures are completely determined from a mathematical point of view given the initial codes, but can from a perceptual point of view look random at first. Gradually we can learn to read the structures and get an abstract feeling for the kind of information that generated the structure and initiated the particular time structure that ticks towards its reference monochrome. If the given information structure is simple, say extremely low activity in e-mail traffic, it is rather easy to read the colour structures displayed by the clock. But if the information is more complex it will take time to figure out what is going on. The difference in structure between different initial colours is also essential. So starting with what at first looks like random noise the viewer will gradually discover a predicable structure that can be very rich. The basic ticking algorithm discussed here can of course be varied in many ways to obtain other types of time structures.

A Clock Displaying Objective and Subjective Time

This clock is built upon the relation between the notion of ”objective” and ”subjective” time, represented by two colour fields (fig. 5). To represent the ”objective” time we have mapped the time to the colour of the outer surrounding field. At midnight it is black, then the colour slowly gets brighter as time goes by, and by noon it is white. It then starts to change back into black during the second half of the day. This effect is achieved by slightly changing the colour of the field once a minute. The nuance is changed according to an hour-long scheme that starts out by increasing (or, during the second half of the day, decreasing) the R value in the RGB-code by one every minute during 20 minutes, repeating this procedure with the G and B values. Thus, every hour, on the hour, the R, G and B values will be the same, making the colour of the composition a nuance of grey. In this way the darkness of the field will show what time of day it is, and the nuance (i.e., slightly red, blue or green) of the field will show how much of the hour has passed. While the very slow changes in colour and abstract code of a RGB-value will prevent most people from perceiving it, this is in fact a real clock that displays exactly what hour and what minute it is.

The notion of ”subjective” time is represented by making the colour of the center field reflect the number of ”events” that have passed, e.g., the amount of digital communication or the number of visitors to the office accumulated during the day. The colour of this field is updated in the same way as the other one, except that it is updated whenever an event takes place, and not when a certain time has elapsed.

Compositions Using Generative Grammars

We also wanted to use more abstract properties, such as complexity or density, of a composition to reflect information. The main problem for such a strategy is how to find a consistent way of creating different versions of a given composition. Searching for a suitable strategy, we found the techniques used in *artificial life* promising [cf. 15].

The possibility of generating increasingly complex patterns using generative grammars have raised great interest among those trying to model how complex patterns with holistic properties can arise in natural systems. So-called *Lindenmeyer systems* were developed for, and have mostly been used for, modelling the visual patterns of flowers, structural properties of plants and trees and other similar phenomena [19]. In contrast, we have used such systems to create abstract patterns, in

Figure 6: #7 after 4 iterations

Figure 7: #7 after 6 iterations

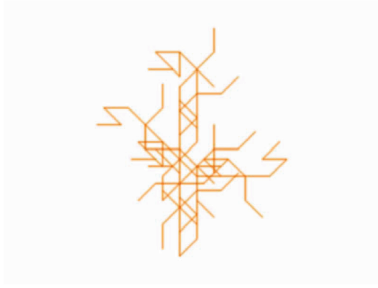

Figure 8: #7 after 8 iterations

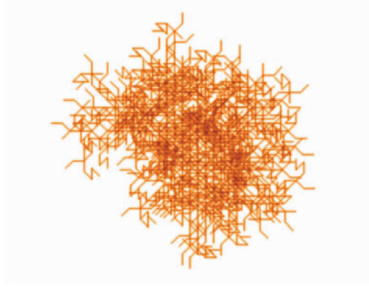

Figure 9: #7 after 13 iterations

Figure 10: #6 after 7 iterations

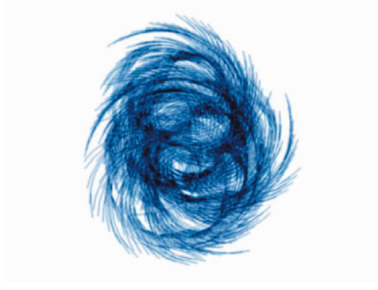

Figure 10: #6 after 14 iterations

which the repetition of shapes and structures are used to create a series of patterns which are logically related to each other.

A Lindenmeyer system is defined by a start condition, a number of production rules and a description of how to interpret them, i.e. a generative grammar which expressions are interpreted as instructions for drawing a figure or a pattern. Iterations of the rules can then be used to generate different versions of the pattern, usually of increased complexity as the number of iterations grow. Although a number of different kinds of generative grammars are employed in Lindenmeyer systems, we have only used context free grammars.

Example

The possibilities with using context free generative grammars are perhaps best described by an example. This is the definition of the pattern used in #7 (fig. 6-fig. 9).

Axiom: X (start condition)

Rules: X: X+Y, Y: Y++[X]

Y is interpreted as "draw a straight line of length l", + as "turn 45° counterclockwise" and […] creates a branch (i.e., [pushes current state on top of stack, and] pops current state from top of stack). X is not given any interpretation in terms of a drawing instruction.

Iterations, *i*, are generated by substituting X and Y with their respective expressions. Thus, we obtain the following instructions for generating a figure:

i=0: X

i=1: X+Y

i=2: X+Y+Y++[X]

i=4: X+Y+Y++[X]+Y++[X]++[X+Y]+Y++[X]++
[X+Y]++[X+Y+Y++[X]] (fig. 6)

We have mapped information about the frequency of communication over e-mail as well as website traffic to the number of iterations. Beside the production rules, the choice of other variables, such as turning angle, also plays an important role to the visual appearance of a pattern (as can be seen in #6 (fig. 10 & fig. 11) in which the turning angle is much smaller, 4°, than in #7, the only other difference being the second production rule where one turn has been eliminated (Y: Y+[X])). Such variables could, of course, also be used for mapping to external information sources.

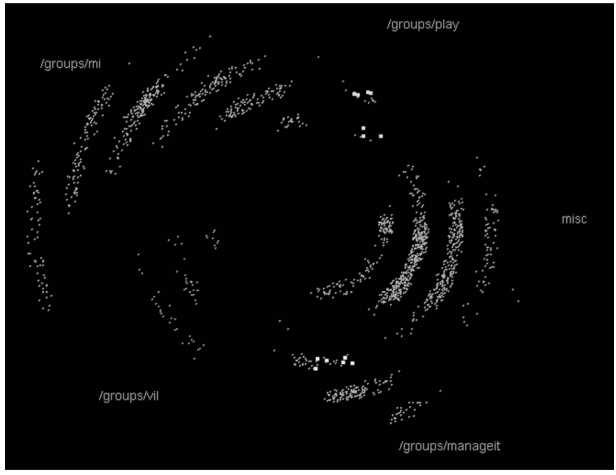

Figure 12: A screenshot of WebAware.

Figure 13: An installation of the ChatterBox using a computerprojector and a sheet of paper hanging from the ceiling in our kitchen.

WebAware - An Example Based on Spatial Layout

Applications that make use of the ”spatial” properties of information (e.g., how different parts are related to each other) are an important area of research on information visualisation. *Web Aware* [24] (fig. 12) is a system that dynamically visualises the traffic on a web site and displays this visualisation in a public place. The purpose of it is to make people in a workplace aware of what is going on on their web site. WebAware falls somewhere between a more traditional information visualisation application and informative art. In being a visualisation on display in a public space, bringing electronic information into the environment, WebAware can be used as an illustration of informative art.

As a basis for the visualisation, a site map based on the external structure of the site is used. The map reflects the hierarchical directory structure of the documents on the server, i.e. documents that are situated close to each other on the server are close to each other on the screen. In this way the map can be said to reflect the ”spatial” features of the tree structure.

In the map, each document is represented by a dot. When a web page is requested from the web server, the corresponding dot on the map is highlighted, and then, as the time lapsed since the download grows larger, will fade back to its original colour. In this way, information about the status of the current web site traffic is mapped to the colour of certain parts of the map, making them stand out from the rest of the map.

ChatterBox - An Example Based on Content

We have also experimented with informative art based on the content of e-mails and webpages. With *the ChatterBox* (fig. 13*)* we wanted to create an entertaining and inspiring information resource based on the e-mails sent around at an office, that also could convey information about on-going activities and projects [21]. When the ChatterBox receives e-mail (in the present version only e-mails explicitly sent to it due to privacy issues), it analyses their content and stores the sentences along with some information about what grammatical relations occur in them, in a database. In parallel to this ”listening”, it also ”talks” continuously in the sense that it generates new sentences based on the material in the database. Finally, the generated sentences are presented on a public display.

We have experimented with a number of different ways of generating sentences. The first prototype employed a technique similar to the ”cut-up” method of William S. Burroughs [25], i.e., to recombine words at random. While this strategy certainly generated new ”sentences”, the presentation was too difficult

to make sense of given the aim to convey information about ongoing activities and projects. This led us to develop more sophisticated methods for analysing the original material and generating sentences that keep more of the original context, e.g., only substitutes parts of sentences with material from other sources. Still, the ChatterBox is capable of delivering quite unpredictable ”statements” about the work at an office.

Discussion

Below, we discuss some of the properties of informative art that might be of importance to future work, as well as when evaluating its relevance for information and interaction design.

Privacy Issues

Whenever information about people's activities is made available, privacy issues have to be addressed. In the case of informative art, certain examples might be perceived as surveillance tools. We think, however, that there are a number of reasons for believing that this will not be the case. First, the examples are symmetrical in the sense that everyone contribute with and have access to the same amount and kind of information. This is a property usually not associated with surveillance where observers usually know much more about the ones they observe, than the observed ones know about the observers.

Second, the information presented in the examples above is abstract. For instance, in the Mondrian-style examples where each coloured field represents one person it is hardly possible to see how many mails she has received and information about to or from whom the mail was sent is not available at all. In addition to that, people watching the display do not know what field represents which person. Further, the information used in the examples presented here is already available to anyone who knows how to obtain it.

This is not, however, to say that privacy is not an issue in informative art, but just to point to a few possible countermeasures for protecting the privacy of the people using it (cf. [11]).

Evaluation

If one wants to evaluate a piece of informative art, what are the relevant questions to ask? In the case of an information display, issues like readability and efficiency of presentation are important criteria when evaluating a design. In the case of an artwork, evaluations in this sense are not relevant at all. Instead reflection and

critical analyses are of interest. Since informative art falls somewhere in between these two categories of design, evaluating pieces of informative art might be a quite complex issue.

For instance, evaluations of the ChatterBox have shown that it can be entertaining and that its output can serve as incitements for spontaneous conversations. However, it was also clear that its usefulness as an awareness support is rather limited, since some people found the recombination of material as more of a degradation of information than as something that could inspire to new ways of looking at the original. This was especially obvious in usage contexts such as at offices, where people seemed to be focused on usefulness and efficiency, properties which the ChatterBox in many respects lack. This illustrates the difference between designing something that have information presentation as its main purpose, and informative art that is designed with other considerations in mind as well, since this might lead to less efficient information presentation. Being clear about the intended purpose with the display, i.e., whether it is an ordinary information display or a ”piece of art”, is obviously of great importance and one has to choose methods for evaluation accordingly. In the end, the main purpose with any evaluation is to gain knowledge about and insights into a certain domain, often in order to be able to explore it further or to improve existing designs. In the case of informative art, evaluations are likely to contain elements from empirical user studies, as well as the kind of reflection and critical analyses normally associated with art rather than information technology.

Slow Technology

Informative art is not very suited to present important or transient information, i.e., information that has to be distributed and attended to within a short timespan. A piece of informative art should not demand continuous attention in order to see if anything interesting has happened. As mentioned above, the difference between a pice of informative art and a more traditional information display might be a matter of degrees and in order to get the most out of the former we believe one has to acknowledge the properties of ordinary pieces of art, posters, pictures etc. Good design for user interfaces of standard applications, like search engines, should promote fast learning, easy understanding, simplicity of use, consistency etc. It is design of fast and efficient technology, of artefacts that are tools, designed for certain specific and well defined purposes.

This type of design goals and its associated guidelines and design methods are not completely obvious when it comes to interaction design as *environmental* de-

sign, as room and space design. *Calm technology* [29] is an example of a different type of approach that comes out of the needs of environmental design

In informative art we would like to add a *slowness* factor. If an object of informative art should be of some interest as an object of reflection it can not be too fast and immediate.
There must be something to reflect on, something to understand that has an interest in its own right. The objects can not just act as tools for fast access to information. Thus there is a need for *slow technology* here, a technology that promotes concentration and reflection.

Information Representation

Compared to work on information visualisation and ambient displays, informative art will be more about how information can be reflected in a structure designed with other criteria than information representation in focus. Thus, it is more about adding a layer of information to an existing structure, than creating a structure that will carry the information from scratch. This might be an important strategy when designing computer augmented, or amplified, environments. If a seamless integration of digital and physical should be possible, the inherent properties of existing objects have to be explored and acknowledged.

We have elaborated on a number of different ways of adding a layer of information to a composition. Properties such as the size, shape and colour of objects, as well more abstract ones, such as complexity and density of a composition, have been employed. These are only samples of possible relationships between artworks and information, and it is easy to imagine a number of other variants and combination of relations as well. For instance, in the compositions using generative grammars only one variable, the number of iterations, was mapped to an external information source. Using the content of the information to control or generate the production rules themselves, as well as mapping information to other variables, e.g., the turning angle, would open up even more possibilities in creating a close relationship between composition and information. Thus, creating the artwork would be much like creating a relation between some information and a certain presentation. The mapping of information structure and design structure of the object surface is clearly of basic importance for an informative art object. This is first of all a matter of intrinsically aesthetical properties of the art object as such. In a piece of informative art the adequacy of information ”presentation” should be a mere consequence of the fact that fundamental aesthetical problems are solved in a satisfactory manner. The art object will in this case not present information as directly as a time table at the railway station, but as inherent in the

composition itself. We can for instance classify the examples presented above in terms of the type of information structure mapping involved:

Mondrian - information maps to the size of local surfaces in the composition

The Klein Clock - information maps to colour codes which completely defines an instance of the clock

The compositions based on generative grammars - information maps to the iteration of the constructing rules for the system

Web Aware - information maps to the spatial layout and colour of the composition.

ChatterBox - explicit information maps in a distorted manner directly on to the surface of the art object

Now if a viewer does not know anything of the background of these things, what would she understand by just watching them for a while? Maybe it would be fun to watch the Mondrian-style display behaving a bit strange, changing the size of local surfaces etc, but if somebody told the observer that this object presents the e-mail traffic at the office, would that make her understand? Our intention is that the objects should function just like art objects, so 'understanding' here just means that one gets a clue to what to look for. The object will mediate between hidden information and presence in the environment. If the structure mapping gives a satisfactory solution to given aesthetical problems, then people watching it will gradually feel a clear presence of information about e-mail traffic when passing by the object or when stopping by for a moment of reflection. This knowledge about e-mail traffic will always be abstract in a certain manner, but this is also one of the main properties of the design space of informative art.

We will not argue that informative art will imply less cognitive load than traditional information displays. On the contrary, the abstract and intricate relations between properties of a composition and some source of information might sometimes be hard to perceive instantly. The benefits of informative art therefore have to be something else. We believe that one of the most interesting properties of informative art is that it opens up a design space where information presentation can be explored from a different point of view.

Conclusions

We have presented the concept of informative art and described its design space in relation to work on information and interaction design. Besides giving a more theoretical account of how the design of informative art differs from the design of other information displays, we have presented a number of examples. The examples were also used to illustrate some of the many different possibilities of mapping information onto a certain structure or composition.

One of the most interesting issues in the design of informative art is the fact that information representation has to be achieved according to quite different criteria compared to more traditional information visualisation. In information visualisation, the structure or composition that carries the information is optimised with regards to the information in question. In informative art, on the other hand, the visualisation has to comply to criteria such as that the overall composition should be motivated from an aesthetical point of view and that the design should be able to fill the role or niche of an art object in a certain space.

Finally, informative art can be seen as a kind of *slow technology* that encourages moments of reflection and concentration in order to understand it. Thus, it stands in contrast to other information displays that are designed with readability and efficiency in mind. Informative art is not about reducing cognitive load, but about inspiring and providing food, rather than fast food, for thought.

Acknowledgements

The authors would like to thank their collaborators at PLAY, especially Lars Erik Holmquist, Patricija Jaksetic, Peter Ljungstrand and Magdalena Siverbo.

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