Aesthetic Computing

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Organised by Paul Fishwick, Roger Malina, and Christa Sommerer

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Edited by Olav W. Bertelsen and Paul Fishwick

Preface

The Aesthetic Computing Seminar was organized by Paul Fishwick (University of Florida), Roger Malina (University of California Berkeley), and Christa Sommerer (ATR Media Integration and Communications Research Lab), and took place at Schloss Dagstuhl in July 2002.

The initial motivation for the seminar was to investigate into alternative, cultural and aesthetically-motivated representations for computer science models such as automata networks, flow graphs, software visualization structures, semantic networks, and information graphs. This was seen as increasingly relevant as the wave of rich, personalized sensory modes became more economic by the perpetual march toward faster and better interfaces. If it were possible to build software models from any material, and with great speed and agility, what new forms of expression would be crafted? It was expected that aesthetics and artist-driven approaches to model representation was about to emerge from more efficient and expressive methods of representation based on advanced technologies. So it was hoped that the advanced possibilities could bring e.g. visualization to be not only about presenting output but also to be about completely new methods of modeling. Thus, Aesthetic Computing was understood as a new trend in modeling and representation where art and science would come together, with art in direct support of science

The mix of artists and academics from all sorts of fields resulted in a fruitful week with inspiring presentations, divergent discussions, and even constructive group work, bringing us closer to an understanding of what aesthetic computing might be, but further away from a definition. In the last session we tried to formulate what aesthetic computing could be about, based on that discussion Paul wrote the aesthetic computing "manifesto".

Olav W. Bertelsen and Paul Fishwick, December 2002.

Aesthetic Computing "Manifesto"

Recorded by Paul Fishwick

The application of computing to aesthetics, and the formation of art and design, has a long history, which reached a substantial state in the 1960s, with the use of hardware, software, and cybernetics to assist in creating art. We propose to look at the complementary area of applying aesthetics to computing. Computing, and its mathematical foundations, have their own significant aesthetics; however, there is currently a difference between the relative plurality and scope of aesthetics in computing when contrasted with art, which has a long history containing a multitude of historical genres and movements. For example, software as written in text or drawn with flow-charting may be considered elegant. But that is not to say that the software could not be rephrased or represented given more advanced media technologies that are available to us today, as compared with when printing was first developed. Such representation need not compromise the goals of abstraction, nor the material or sensory engagement used to formulate the constituent signs for a given level. Abstraction is a necessary but not sufficient condition for mathematics and computing, as meaning, comprehension, and motivation may be enhanced if the presentation includes additional cognitive or aesthetic elements. Such presentation may involve multiple sensory modalities.

Computer programs have been traditionally presented in standard mathematical notation even though, recently, substantial progress has been made in areas such as software and information visualization to enable formal structures to be comprehended and experienced by larger and more diverse populations. And yet, even in these visualization approaches, there is a tendency toward the mass-media approach of standardized design, rather than an approach that takes account of a more cultural, personal, and customized set of aesthetics. The benefits of these latter qualities are:

1) an emphasis on creativity and innovative exploration of media for software and mathematical structures,
2) leveraging personalization and customization of computing structures at the group and individual levels, and
3) enlarging the set of people who can use and understand computing.

The computing professional gains flexibility in aesthetics, and associated psychological attributes such as improved mnemonics, comprehension, and motivation. The artist gains the benefits associated with thinking of software, and underlying mathematical structures, as raw material for making art. With these benefits in mind, we have created a new term Aesthetic Computing, which we define as the theory, practice and application of aesthetics in computing.

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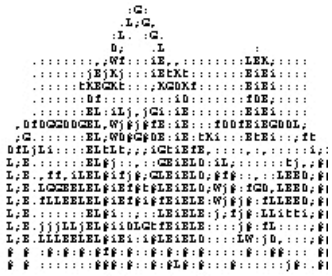


DAGSTUHL, 2002

aesthetic computing workshop - my approach, based on culture_distinction

```
predicates:
{
 art_software_relations:
        {software, as art, is means of creating and broadcasting ideas,
        --> similarities and relations of both when examining aesthetics
        }
 culture_derived:
        {aesthetics of our environments is culture based and influenced by social changes
        & culture fluctuations
        }
 culture_distinction:
        {the web hosts 2 cultures (thus aesthetic elements):
         // this distinction can be shown on web evolution
            of text based and 2d since the 80's
         define global_sub_culture(1) == top-down_culture;
         define top-down_culture:
                elite, commercial, money&power oriented, centralized, hierarchical, close...;
         define examples(top-down_culture): hollywood, ms, aol, nyse...;
         define aesthetics(top-down_culture):
                limit users functionality and details, hi-price/hi-color/hi-resolution,
                                                              pr minded, patent oriented;
         or
         define global_sub_culture(2) == bottom-up_culture;
         define bottom-up_culture:
                open, distributed, community oriented, security minded, identity watch_dog;
         define examples(bottom-up_culture): hackers, games, artists, porno...;
                //as opposed to classic "popolus diffusion" culture theories,
                  cyberculture popolus is professional elite
         define aesthetics(bottom-up_culture):
                functional, code elegant, skinable, hooks to text, free/open libraries,
                script_lang admiration, meta rating mechanisms, simple/algorithmic graphics;
        }
 pure_aesthetics:
        {community oriented and for the community - as opposed to showing off and selling better...
         as in [home-brew pc's, chip paintings, rfc's, irc, slashdot, sourceforge...]
        }
}
```

This image was created by C.Y.B.O.R.G. algorithm.
I am not a lisp machine, but this is the "code" of my culture_distinction based thoughts...

from aesthetics of hackers & gaming ===> to 3D/VR web based future

Paul Fishwick suggests that we can use science fiction (e.g. star trek) to guess how 3D/VR web based systems will look like, 5-10 years from now, assuming broadband and cpu become cheaper and faster. I'd like to refine this statement, and to suggest an approach on how to do this, based on culture distinction, by examining current stat of gaming industry and 3d/VR hackers communities, assuming they represent important factor, as shown to be true in text/2d transition process.

```
function guess_what()
if {
        (sci-fi [e.g. star-trek] = top-down_elements (hollywood)
                                 + bottom-up_elements (hackers, gaming industry);
        and
        (status [3d/vr web based today] = status [2d/text web based in the 80's and 90
   }
then
   {
        examine current [3d/vr web based];
        and
        predict future [3d/vr web based];
   }
endif
```

---

timeline

```
        aesthetics of bottom_up                          aesthetics of top_down
_____________________________________________________________________________
80's    bbs design - basically hackers oriented
90's    text based and 2d sites, graphic browsers
        ms not playing significant part,
        (neither in standards nor in industry).
                                =======
                                       \\
                                        \\
                                          ======>    commercial web
2k                                                   text/2d/streaming
                                                     hybrid influences - bottom_up & top_down
                                <<=================>>
                                       cross_culture: flash, java, xml...

        music - mp3, peer2peer
        games - doom, quakeII - open!!
        interactive tv - walled garden vs. closed garden
        porno/cellular - On-the-go porn
        3d web based (Plastic Planet,Bruce Damer,3D Cafe)

                                =======
                                       \\
                                        \\
                                          ========>    ??????????
                                       Star-Trek 3D convention
                                       NYSE-VR vs. NYSE Marketrac
```

-- back_to_code --

Aesthetics as Means for Supporting Development in Use - Beyond the Designed Purposefulness

Olav W. Bertelsen

I am sure aesthetics should be brought to the interface. Not as Aristotelian rules, but as authentic, emancipatory praxis where unexpected things can happen. The basic aesthetic problem in design of computer artefacts is that everything in an interface is planned, or should be. Unexpected stuff on your screen is the result of bad design and it will cause immediate frustration. While the aesthetics of the modern world is constituted by a contingent stream of experience‹truck horns, TV-antennas, paint peeling of a wall› the world of computers only supplies us with over planned images. What is needed in this functional, concrete dessert is more TV-antennas.

Human-computer interaction (HCI) has been concerned with the situation of use. Minimising intrusiveness of the interface has been the goal; users should be able to do their work instead of dealing with the computer. The recurring problem, though, has been that tasks, users, and applications have been understood as more or less stable entities.

Approaches to HCI based on activity theory have emphasised the fundamentally dynamic nature of the use situation. However, most of these approaches seem to be trapped in the notion of purposeful action. Reducing design processes to a search for a solution to a recognised problem and reducing impact of the acknowledged dynamics of the use situation. Historically, it has been important to make the new artefact fit the concerned practice, and it has been important to introduce the involvement of users as part of an emancipatory program for expansive design. However, emancipation seems to be subsumed under the purposeful adaptation of changing technologies to the evolving working culture.

In the same manner, attempts to take the users enjoyable experience into account mostly seem to reduce the aesthetics of the use situation to purposeful means for achieving something else, e.g. efficient interaction.

The problem is the paradoxical one of meeting needs that don't yet exist, supporting the development of practise that we cannot yet imagine. The claim made in this paper is that part of the solution can be found in modern aesthetics. For the course of the argument we distinguish between classical aesthetics, aiming at catharsis, pleasure and balance; and the modern aesthetics aiming for disturbance, excitement and dynamics.

In the analysis of the relation between perception and action, Wartofsky argues that perception is a mode of outward action. Action and perception, human beings relation to their surroundings, is mediated by three classes of artefacts, of which tertiary artefacts reside in an off line loop, detached from direct productive practice. Tertiary artefacts affect production through their reformation of our perception. Tertiary artefacts define a room without purpose, aesthetics. The key to an (operational) understanding of the radical dynamics in the interface (support for development in use), and the innovative (expansive) potentials in design is aesthetics. In the interface the concept of tertiary artefacts extends the notion of socially mediated development in use beyond the planned and the purposeful.

Tertiary artefacts seems to be a key concept in a dialectical and materialistic understanding of modern aesthetics, and how such an understanding can bring HCI beyond its over emphasis on purposefulness.

Real Reality – How to use Reality to structure Virtuality

Willi Bruns

Real Reality, a reaction on the silly term Virtual Reality, is a concept to use real concrete objects to build virtual computer models, support mental modelling and communication of a group.

With a flexible type of interface (Hyperbonds) which easily allows to connect computer internal logic with external physical phenomena, we try to support the playful perception and action in both worlds, the real and the virtual (virtual meant in its double sense as computer generated 'display' and as human imagination).

Aesthetics, as a position, may be seen as a medium between sensuousness and intellect. Its objective and purpose being the development of sensitive cognition in order to liberate ourselves from "repressive productivity" towards "creative receptivity" (H. Marcuse). Play and dis-play (Schein), unproductive and useless "purposiveness without purpose" may well constitute a new position in systems design, where we focus more on contemplation/reflection than rational purpose oriented efficiency. Four examples of work in this direction are presented.

Theatre of Machines. In a student project of informatics and performing art, a struggle for control between a philharmonic musician, an avatar, a concrete marionette and some robots is elucidated on stage. The avatar, the marionette, the robot and the musician are at first controlled by some persons behind the curtain, a computer-graphics specialist, a marionette player, a robot controller and the dead composer, when suddenly the musician tries to take over control of the machinery by some mechanism of gallows like sensoric device and a computer mediated control algorithm. The question rises: Who is controlling whom?

Programming by concrete demonstration. A design team for an automated transport and manufacturing system is playing at a modelling desk, trying out alternative solutions for the geometric, topological, behavioural and functional specification of a planed factory with concrete small model-parts (conveyor belts, machines, palettes). Through some sensors, recognising their handling, and following a well defined language of grasping and moving, the actors are able to specify the system in all its details, including the algorithm for the programmable logic controller (PLC), a device to control the real automation system.

Supporting mixed realities by Hyperbonds. A sensor-actor interface for various physical phenomena crossing the boarder between the real and virtual world is introduced. A row of plug connections for tubes of air-flow and electric current, fixed below the monitor or the projecting screen, is mirrored by its computer internal virtual representation in a VRML-scene and its 2D-visualisation on the screen. The modelling in distributed virtual worlds may now easily be connected with real parts of a complementary system. By connecting the input/output of a certain virtual part through drag and drop with a virtual pin of the hyperbond and continuing the corresponding real connection (by wire or tube) to a real component, the overall functioning of the system, distributed between local and remote, real and virtual worlds, may be constituted or preserved.

Learning in mixed realities. The strength of synchronously modelling in real and virtual worlds haa been demonstrated in a learning environment for mechatronics, where students could start with simple real components to learn about simple mechanisms of electro-pneumatics and graduate towards more and more complex systems up to a modular production system for small parts. The ease of shifting perspectives between the concrete and various levels of abstraction is open for various teaching and learning styles.

Programming as an Art Form

Annick Bureaud

In the early days of computing in art, the artists had no choice but to develop their own programs. Some of them were deliberately working on computing as art and/or computing as an art tool (Harold Cohen, Peter Beyls, Vera Molnar, Manfred Mohr, Frieder Nake, etc.). Then, we witnessed the birth of the software industry that provides "packaged programs" to anybody including artists (i.e. Photoshop, Director, etc.). I make a difference between a "program" that is dedicated and "hand made" for a specific purpose and a "software" that is general and "mass produced". Today, there is a sort of "come back" to programming as an art form or a tool for art. We can see it in the very existence of this seminar as well as in the new Software Art price put together by Transmediale, or the distinction between the prices "Net Excellence" and "Net Vision" of Ars Electronica. The Internet has drawn again the attention to the "code" (i.e. the language). From my point of view there are different levels of programming and "art of the code" (as we say in French) : 1) writing code to produce artworks that deals with the code, which content *is* the code ; 2) writing specific code to achieve some effects, some artwork (i.e. digital literature, specifically the French trend is a very good example of that) and 3) artworks based on the GUI and/or the existing Internet tools and codes (like all the artistic works about browsers for instance and most of the net.art pieces).

I am interested in figuring out what are the different typologies of "software art", aesthetic computing, the relations and differences from the early days and what kinds of aesthetics is emerging from this, what kinds of art forms and "objects".

Software Visualization

Stephan Diehl

Software Visualization is concerned with the visualization of artefacts related to software and its development process. Computer science terminology is full of metaphors: automata, machines, tapes, trees, leaves, queues, files, folder, windows, to name a few. Computer graphical representations for designing and implementing systems are widely used in other engineering disciplines. Surprisingly enough, we find that computer scientists make only little use of visualization to support the development of software. In our presentation we gave examples of several different software visualization tools. We found that so far effectiveness (purposeful, ease of use, ...), not beauty (purposeless, emotion, intuition, art, creativity) has been the main focus of these systems.

In a recent survey 82 percent of researchers from software maintenance, re-engineering and reverse engineering found software visualization absolutely necessary or at least important but not critical for their work. Nevertheless, only a few researchers investigate the use of software visualization in different areas. Often researchers apply existing techniques in their areas in an *ad hoc* way and are disappointed by the results. Consequently, our claim is that software visualization must be regarded as a research area of its own.

Is there any computing that is not aesthetic?

Florian Dombois

Computers are calculating machines organised by software codes. When attached to visual and/ or audio displays they can render images and sounds which give rise to various new media. It is all too natural that on the one hand artists like to make use of these new spaces of expression, and on the other hand that the programmers, who code these pictures and sounds (that might never have been seen or heard before) like to call their work art.

But there is a resistance within digital media that makes the production of art in my opinion especially difficult and different from the traditional forms of expression, which is the conceptual dichotomy of code and representation. Shall we search for aesthetics and art in the code or in the displayed picture? Does a piece exists that fulfill both aspects of quality? Then can a professional artist become good enough in programming to produce an 'aesthetic code'? Can a professional programmer develop an artistic skill of professional quality? If not, can an interdisciplinary team create a computer art piece of aesthetic relevance? Who is the author then? And how could a piece of artistic qualities in code and representation be presented and perceived in an art show?

Furthermore, digital media are not fixed to a certain machine or a specific display. Where do we find the original, which machine has the 'master-tape'? Does the artistic side of the piece change when adapted to a different software architecture or a different screen? Or do we need to keep the 'original' machines and displays?

Nevertheless there is also a facilitation within digital media that makes the perception and judgement of art intricate, which is the all too aesthetic quality of every display. Is there any picture or any sound that is not changed to 'beauty' when presented on a projection, a flat panel, a high-tech hi-fi sound-system? Can it be avoided that the screen or the speaker is aesthetisizing the code, the picture or the sound? Can digital art ever be ugly? And if not, is there any computing that is not aesthetic?

Generative Interactive Systems With Meta-Rules - Learning From Experience

Ernest Edmonds

The paper describes recent developments in Video Constructs, the basic versions of which are generative abstract computer animations. In video constructs, the logic in the computer provides the underlying structure that leads to the form of the work. The most exciting element of the constructive video is, perhaps, the careful and very terse way in which a specification of what occurs in time is possible. The brevity of the specification is extremely important in the development of ideas. The inevitable exploration is so strongly supported by this aspect of the use of the computer that new ways of thinking about work emerge in their very construction. This has led to developments both in interaction and in changing behaviors as the result of experience.

The time-based video constructs have developed into interactive video constructs. It is not hard to understand how the structures in time can be so constructed as to react to events detected by sensor systems. A real time image analysis system is incorporated into the generative program. The behaviour of the piece, i.e. the generative path that it takes, is then reactive to what participants are doing or what music is being played.

A video construct is searching through a set of rules and, as it does so, generating the sequence of images that form the output of the work. Each image represents the state of the search at that moment. In the earlier systems the sequence of states was entirely determined by the search strategy used by the software to explore the rules. In the interactive case, however, the search engine has available to it a stream of data that is a coded representation of the behavior of the viewer and this data modifies parameters in the search, thus leading to a sense of reaction by the system to the participant.

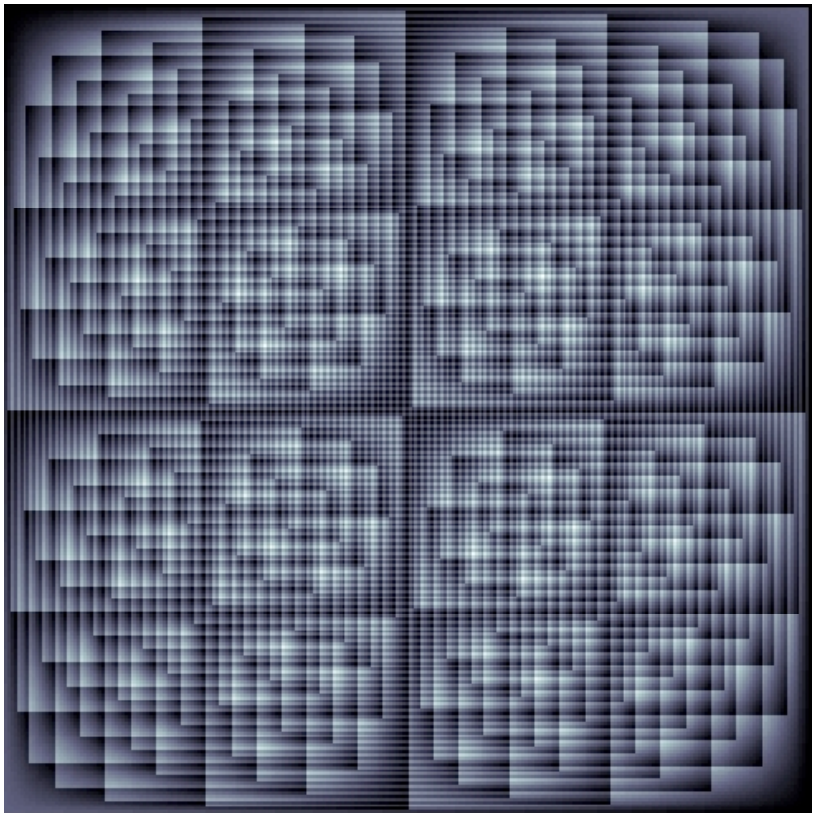
Because these interactive video constructs are described within the computer by a set of rules, it is possible to add meta-rules, that use the history of interactions between participants and the work to modify the generative behavior by changing the rules used, or changing which rules are used. The latest work that will be described in the paper does exactly that. By recording and analysing the interactions in real-time, the system applies meta-rules as it learns from experience about human reaction to it. The video construct changes its behavior in the light of its experience with human participants interacting with the work. Because, at its core, the work is a generative system, as it learns it changes the way that it develops rather than simply the stimulus-response rules that govern its behaviour.

The learning interactive video construct is a living growing art system.

CONSTRUCTING INTER-RELATIONSHIPS

Aesthetic Discrepancy

Karl Entacher



The graphic above visualizes local discrepancy of a special point set in the unit square. Discrepancy is a classical measure of the theory of uniform distribution modulo one. It determines the quality of equidistiribution. The theory of uniform distribution deals with - nomen est omen - uniformly distributed point sets and sequences. It includes extensive developments within and among several mathematical disciplines and numerous applications, mostly in the fields of Monte-Carlo- and quasi-Monte Carlo Methods (including areas like numerical integration, random number generation, stochastic simulation and approximation theory). Using graphical representations of (local) discrepancy, I want to demonstrate my understanding of the "beauty" of this theory.

References:

K. Entacher. Discrepancy Estimates Based on Haar Functions. *Mathematics and Computers in Simulation, 55, 49--57, 2001.*
<http://www.fh-sbg.ac.at/~entacher/papers/discrepancy2.pdf>

K. Entacher. Schöne Theorie der Gleichverteilung. *NOEO Wissenschaftsmagazin Salzburger Bildungs- und Forschungseinrichtungen, Ausgabe 01/2001.*
<http://www.fh-sbg.ac.at/~entacher/papers/beauty.ZIP>

Remaking Mathematics: Art on the Inside

Paul Fishwick

Can the notation for software and mathematics change, and what would it look like if it did? First off, the notations for both mathematics and software have indeed been changing. For mathematics, notation has undergone gradual change over the centuries, and for programs and data structures, we are in an era where 2D graphical displays can be used to represent program logic. What about radical change? Can mathematical structures be built out of any material, and with a variety of styles and aesthetics? Before we depart on the notion of radical change, let's consider some justifying trends. Media has become cheaper to produce, with 3D hardware now installed inside of every personal computer. True 3D displays are routinely touted in the print media, and rapid prototyping machines create material objects from raw material, such as dragons and automobile part prototypes from a resin bath. If aesthetics are to play a role in reforming mathematical notation then personalization and customization must also be justified. In recent years, both of these areas are spawning new research areas within computer science and business. It is no longer acceptable to have "one for all". We want it done "our way." The technology is making it economically feasible to do just this. If these trends are making it easier to remake media, then it is only a matter of time when we question our mathematical notation and everything built upon it, such as computer software. It is not that we would have necessarily done anything different if we represented Pythagoras Theorem out of trees, rivers, and people. However, maybe we might understand the notation better, and more people would come to understand software. For the past two years, we have been researching the borderlands between Fine Art and Engineering in the place where mathematical and software notation live. Our work is documented in the rube Project Area. (http://www.cise.ufl.edu/~fishwick/rube)

Aesthetics and Algorithmics

Frieder Nake & Susan Grabowski

The term "Aesthetic Computing" comes as a surprise. It combines two aspects of reality in an unsymmetric way. Its syntax indicates that "computing" is the governing aspect. We are obviously talking about a particular kind of computing: a kind of computing that is characterized as "aesthetic". Aesthetics pertains to sensual perception. It is understood by many as the issue of the beauty of a situation. We take a slightly different view.

Recall the three kinds of value judgments that get dealt with in logics, ethics, and aesthetics, resp.: the value dichotomies of true/false, good/evil, and beautiful/ugly. We have listed them here according to increasing subjectivity. As we move from logics to aesthetics, more of the specifics of the given situation and of the context must be considered. When asking for the (logical) truth of something, we tend to, and actually must, ignore a maximum of context. On the other hand, when judging the situation's beauty, we express our individual and personal feelings. We prove the truth. We justify the good. We feel the beauty.

Against such a (very simplified) background, "aesthetics" is what you cannot prove to be correct, nor justify as being good. In science, we strive for truth[1]. Whenever science advances, art loses a bit (D. E. Knuth, Things a computer scientist rarely talks about, 2001).

Aesthetc computing would be that type of computing where something is judged aesthetically. That something could be the software itself, or the product of some application of a piece of software, or the very process of an application of software. In other words, the object of aesthetic evaluation could first be the program itself (or algorithm, or programming language, or data model): something from the hard core of informatics. That object could, secondly, be an object, process, or installation generated by an artist who is using software in his or her attempt at generating a work of art. In that case, we are dealing with algorithmic art, or an interactive installation, or the like. The object under consideration could thirdly be the very use of the software itself. Our concern would then become human-computer interaction, and the software interface.

We see here that the products of informatics proper, of computer art, or of HCI may each become the object of an aesthetic value judgment. In a particular case of aesthetic computing we would have to decide which one of these aspects would act as the subject matter.

We prefer to take a more symmetric view of the situation. That could be expressed by using the expression "algorithmics and aesthetics". The two areas appear here on the same level, combined by the undirected copula "and". A dialectics is appearing in the combination. It is the dialectics of the computable and the sensually perceivable. The computable may be characterized by prediction, determination, closure, security, purity. The perceivable may be characterized by sensation, interpretation, openness, instability, noise. Joining the two aspects establishes a tension, or a contradiction. A contradiction is nothing we should be afraid of. To the contrary, it is the reason for change, development, and process.

If we treat a situation dialectically, we identify its polar aspects and view their tension as the driving force for development. It should be possible to identify, in one term, the general form that development could take. We believe, indeed, that there is such a term, which is to say there is a way

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Well, not quite. Many have given up that goal. Perhaps something like "agreement within the scientific community" or "consistency of model with observed data" is nowadays closer to the accepted goal of science.

of looking at the situation of aesthetics and algorithmics that allows us to deal with forms of movement initiated by the dialectics of aesthetics and algorithmics. This is the *semiotic* view.

Algorithmics deals with the special kind of signs that we call algorithmic sign. We cannot here go into any detail explaining that concept. It must suffice to say that the algorithmic sign possesses two interpretants[2]. One interpretant is generated by the human participant of the situation. The second interpretant is, oddly enough, generated by the computer[3].

Aesthetics deals with aesthetic signs. These are signs of the classical kind but in a special function. As always, when we think of "signs", we should not think of one static sign but of sign processes (semioses). Signs are not so much static entities but rather changing ones. Such semioses display their aesthetics when we consider judgments of unity in variety, order in chaos, surprise in expectation, immediate appeal in hidden expression, selection and composition, and more. The dialectics we would have to study are such that art corrupts the algorithm, and calculation destructs the masterpiece.

So algorithmics as well as aesthetics allow, and call, for semiotics. In semiotics we find a possibility of at least describing what we deal with in "aesthetics and algorithmics". A description that a community agrees upon, may help to better identify the situation at hand.

And, by the way, if we think of the aesthetics of the products of software, we should better think of classes of objects than of isolated individual objects. A piece of software stands for the design of possible designs. – In our own case, we are interested in the transition from the peculiarities of a computer art project to the general contradictions of aesthetics and algorithmics viewed under a semiotic perspective.

Admittedly, this is all quite general and abstract. It may help to realize that beauty can exist only where ugliness is also welcome. Likewise, computability can exist only where chaos is also welcome. To name examples from either field that display the quality of the other: there is definitely a lot of aesthetics in Donald Knuth's software. There is decidedly a lot of algorithmics in Max Bill's paintings.

Think of rules! Rules appear in mathematics in their most general form: as theorems that can be proved. They thus become true for everyone who is willing to follow the argument of the proof. On the other hand, rules appear in the arts in their most singular form: as art works that can be displayed, and thus become admired by those who are willing to detect something for themselves.

We would like to add a last remark in taking up the suggestion by Boris Müller, to consider software as material. He demonstrated, in three diagrams, the views of software as tool, as medium, and finally as material. This last view may prove to be helpful when studying artists using computers.

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[2] The interpretant is one of three aspects of the concept of sign that Charles S. Peirce has introduced (viz., e.g., The Essential Peirce, vol. II, ed. by the Peirce Edition Project, Bloomington 1998). The other two aspects of the sign are the representamen and the object. A sign is a first (representamen) standing for a second (object) expressing a third (interpretant).

[3] For a more detailed explanation of this concept, we refer to the book in preparation, "Informatics and semiotics" by Peter Bøgh Andersen & Frieder Nake. It should be mentioned, that Jay Bolter in his book, Writing Space (1991), describes the situation of a human with a computer in a similar way but in different words.

The artist or designer is working on some material that she wants to shape. The material develops resistance against that shaping. The artist, in her attempt to reach her goal, must break the resistance. The process of aesthetic production is largely characterized this way.

Now – if the process of software development is to be viewed from an aesthetic perspective, it follows from the same logic, that some resistance must be overcome. That leads us to assume the software itself to be the source of resistance. But the software is only emerging during the process under consideration.

We tend to assume that the character of software, when viewed from an aesthetic perspective, is a special one that we must understand in order to understand the inner working of aesthetic computing. Whereas material in the classical sense of the word has a character like corporeal things, software-material is of relational nature. That means, it is of semiotc nature. Transgressing fom static objects as works of art to such relations (which are objects in the state of fluidity) appears as the new challenge to aesthetic production.

Aesthetic aspects of surface modelling

Hans Hagen

The geometrical modelling part of simulations is of central importance in nearly all applications. Apart from the pure construction of curves and surfaces, the analysis of their quality is equally important in the design and manufacturing process. It is, for example, very important to test the convexity of a surface, to pinpoint inflection - points, to visualize flat points and the technical smoothness of surfaces. We have developed special algorithms to deal with these kinds of problems. At the present time our solutions are state of the art in industry, but at least one interesting problem is not solved yet:

Aesthetic Feature Modelling

Aesthetic aspects of surface modelling are currently "tested" by simulations of reflection line patterns.

- Is this the only way?
- How can we use reflection line patterns in a feature modelling approach?

We give a short survey of existing methods and try to approach these two topics in this talk.

The aesthetics of interaction

Volker Höhing

The classic art and design media like painting, graphics and sculpture etcetera have very long been analyzed for their aesthetic aspects. They have been described and defined in models and schemes like composition schemes, color schemes und proportion rules. The broad availability of computer technology added a new type of medium: the interface between man and machine. Trough the interface defined by monitor and mouse, output and input the basic interaction with an application arises. The design of the interface is currently focused on the design of the output and is generally described with the term "interface design".

Interface design consists of the areas of conceptual, interaction and visual design. The aesthetic qualities of visual design follow largely those of traditional media – but are realized on a different canvas. Drawings on stone or paper boost or prevent different aesthetic qualities – likewise the visual design has its own boosting on the screen.

The aesthetic qualities of conceptual and interaction design have been nearly unstudied and were predominantly researched under ergonomic and economic points of view. Interaction design is a quality that is innate to the computer. To approach to the field of interaction design it is reasonable to have a look at the atomic items of interaction design and the design patterns. The term "design pattern" refers to the basic interaction vectors, the entirety of input and output possibilities in the digital world, for instance navigation elements like tree structures, breadcrumbs etc. These atomic interaction elements could be examined in the context of their usage. To enable the designer to select the ideal design pattern, a taxonomy has to be defined. This taxonomy could contain criteria like context, user type, task, goal, etc. The goal of this taxonomy is to give the designer a selection of context specific design patterns that allow to choose design patterns beside of the intuitive and subjective level.

It could be assumed that the combination of ideal design patterns could show aesthetic structures itself – by researching eye-tracking and mouse-tracking data. This could be useful to verify the quality of interfaces.

Aesthetic Pleasantness Related to Trusting Behaviour

Kristiina Karvonen

Aesthetics as a decision-making tool for trust

I am interested in how people may use aesthetic considerations as decision-making tools: considering an e-commerce site beautiful may be an important step in judging its trustworthiness - in a true and rational fashion. I mean, seeing the site as *beautiful* may be based on it really being *trustworthy*. If so, this would mean that aesthetic considerations are rich in information and are based on a rational reaction and information-processing. The next step, then, would be to try to see if trusting decisions made on basis of perceived beauty prove to be valid means to reach a good decision - that the site perceived to be beautiful is, in reality, also trustworthy. But first we need to know what is beautiful - or aesthetic - in this context, before we can go any further.

Beauty of Simplicity

This paper has caused a lot of questions, raised a lot of interest and created some common misunderstandings. I guess I should have been more clear in my presentation.. My main motivation for writing the paper on the "The Beauty of Simplicity" [1] for CUU 2000 was just to raise the awareness on aesthetics - both to emphasise the importance of understanding the significance of aesthetics for the user experience and HCI, as well as to try to create some guidelines for how to find these aesthetics. I also felt frustrated when reading or listening to presentations on the aesthetics of user interfaces that were rather trivial - people were just trying to invent aesthetics anew. The result is some kind of "*folk aesthetics*", as compared with "folk psychology" - sometimes right, sometimes wrong, but in no systematic fashion, and with a lot of *superstition, stereotypes, and false beliefs* involved. So, I needed to comment on that to get it off my chest, so to speak.

Actually, I never meant to say that *simplicity* would be enough. I recently read my paper through and I guess one can get that idea from it, especially since the title is the way it is. The main idea in my paper was to suggest that when one needs knowledge of aesthetics, why not put a "pro" to investigate it - a real aesthetician. Simplicity is more related to Mr. Nielsen's book and its name ("practice of simplicity"), and of course to the perhaps partial truth that it tells about what matters in usability: simplicity is important.

I stressed simplicity for two further reasons: firstly, since I wanted to stress that even simplicity may need to be aesthetic in order to be appreciated, and secondly, because the "beauty of simplicity" seems to be the right kind of beauty or aesthetics to induce trusting behaviour, when conducting transactions online - or at least so my Nordic user studies (Finland [2], Sweden [3], Iceland [4]) seem to suggest. Users seem to prefer refined, simplistic design when they are making a purchase online. However, I too feel that this is only a part of the truth. Much more investigation needs to be done, and for other types of interaction a different kind of aesthetics may be needed. The same goes for users with different cultural backgrounds.

What about user experience and aesthetics?

Since aesthetics clearly involves the idea of *having an experience* at least at some level, the area of user experience seems relevant to studying it. However, even if I know that the intentions and objectives of this new and trendy approach are good, I'm troubled by it. Broadening the scope of usability from the traditional engineering methods toolbox into embracing the totality of user experience as a more holistic process is definitely *OK*. However, *how to get there* still escapes me. Please, show me how really to delve into the depths of the human experience per se and I'll be more than greatful. In any case, I'm sure this approach will be the one under which aesthetical issues will be investigated. However, I feel it is possible to think about *aesthetics also without experience*, so

the study of aesthetics in relation to usability does not completely fall under the study of user experience.

Aesthetics and emotions
Donald Norman has recently taken up resolving the combination of emotion & design [5]. The same goes for Nielsen, a former "usability purist": he now emphasises the fun factor [6]. In doing this, they seem to consider aesthetics and emotions as a closely tied bundle. But how closely is aesthetics connected with emotions, and are they always connected? For example, if you think of the old (and now, for the most discarded) idea of *disinterestedness* as an essential element of aesthetic considerations, how might that relate to usability? I'm not so sure if aesthetics always goes hand in hand with emotions and emotional reactions. I think *the two are separate issues* to some extent - not all aesthetic experiences need to be emotional, or do they? I don't think so. I think it is perfectly possible to appreciate something aesthetically without getting emotional about it. Getting emotional denotes commitment. I think *commitment* or getting involved is one important aspect of experiencing an emotion, whereas aesthetics is more about *appreciation*, which may or may not involve commitment as well.

Also, sometimes among art historians at least an emotional reaction towards an art object may be considered too mundane. It is sometimes felt that an emotional reaction denotes that there is no intellectual reaction. An emotional reaction may be seen as inferior to higher forms of aesthetical appreciations. Sometimes it is felt that best art tickles the brain and not so much the senses. However, I think things are not that straightforward, and perhaps "best art" (if there is such a thing) tickles everything.

Also, the "average man" usually craves for having emotional reactions when confronted with art, even if brainteaser-artworks are also usually found rewarding by the general public. (These experiences stem from years of direct contact with the "general public" while working as an art guide in art museums during my study years.) So *emotions do matter*, in one way or the other, for experiencing and appreciating art, as well as other things besides art. But not all pleasure comes from aesthetics.

To conclude, I am not that interested in emotions and design per se, but I guess interest in those issues naturally follows from my other interests, namely 1) aesthetics and usability and 2) trust - both areas clearly involving emotions.

What about beauty - i.e. aesthetics of what?
Of course, these days not even art, and far less other things in life, are mainly, if at all, about aesthetics or at least they are often not beautiful, yet significant in other ways. *Beauty is not everything*. In fact, making beautiful art has been a suspicious activity within art circles for quite some time now, as I'm sure you are well aware of. "Beautiful" is sometimes considered trivial and naive. The worst comment an artist can receive of his or her works from an art critic seems to be to say that his or her works are "beautiful". So "aesthetic" may sometimes be a negative term (as is, in fact, also the case in Don Norman's book on The Psychology of Every-Day Design), and further, "aeshtetics" might also mean "appreciation of the ugly". What it means is that the *context* where aesthetics is considered becomes crucial. With "aesthetics" we may sometimes mean the *aesthetics of the ugly*, or *the aesthetics of the grotesque*, for example - we must pay attention to who's speaking to be able to determine which is the case.

Aesthetics of interaction =?
One further issue is the *dynamics* of the use situation. An essential element of the user experience is *time* and *change*. What are the makings of an aesthetic interaction? The feeling of *flow* - an

uninterrupted, smooth state of concentration without conscious effort - is often mentioned. But what does it mean, and how can it be deliberately achived? And how can such a state be analysed?

These all are issues that I'd like to try to ponder upon and work with in the future.

Refences

[1] http://www.tml.hut.fi/Research/TeSSA/Papers/Karvonen/CUU2000_Karvonen_K.pdf
[2] http://www.cs.hut.fi/~karvonen/karvonen99creating.pdf
[3] http://www.tml.hut.fi/Research/TeSSA/Papers/Karvonen/Karvonen_Cardholm_Nordsec_final.pdf
[4] http://www.cs.hut.fi/~karvonen/designing-trust.pdf
[5] http://www.jnd.org/dn.mss/Emotion-and-design.html
[6] [a]http://www.useit.com/alertbox/20020707.html

Aesthetics and the semantics of graphics: a position statement

John Lee

I have been involved for a long time in work on trying to understand the nature of graphics as a communication system and medium for supporting activities such as design and reasoning. This has included attempts to formalise fragments of graphics and give them a clear semantics, and to build computer-based tools for analysing or performing graphical reasoning (cf. Wang and Lee, 1994; Wang et al 1995).

More recently, I recognised that a somewhat similar enterprise has been going on in aesthetics. The pages of e.g. the *British Journal of Aesthetics* are often host to discussions of closely related issues.

Attempting to bring these two perspectives together, I was drawn to the seminal work of the late Nelson Goodman (1969). His notion of a symbol system, quite different from e.g. that of Peirce, seemed well positioned for an approach from both directions. A number of his concepts, especially that of "exemplification", turned out to be very useful. A feature of Goodman's discussions, however, is a very strong emphasis on syntax, which I propose (Lee 1998) should be tempered by a fuller realisation of the central role of semantics in determining the nature of a symbol system.

In graphics, perhaps even more clearly than in language, it is evident that semantics is best seen as emerging from the use of the medium in particular ways in particular contexts. An ongoing study of graphics in communication (Lee 2002) reveals that some kind of dialogical framework involving a feedback loop is crucial to this emergence. It seems fair to conjecture that what happens on a small scale in dialogues and group usage is implicated, if not mirrored, at the larger scale where e.g. aesthetic judgements emerge as culturally conditioned responses.

Working with colleagues to develop a framework in cognitive theory within which to address these issues, I am keen to develop discussion on the possible application of computational concepts in this area.

References

Goodman, N (1969) Languages of Art, Oxford university Press.

Lee, J (1999) Words and pictures -- Goodman revisited. In Paton, R. and Neilson, I, eds, Visual Representations and Interpretations, pp. 21-31. London: Springer-Verlag.

Lee, J (2002) Modes of representation in graphical communication. To be presented at Visual Representations and Interpretations 2002, Liverpool.

Wang, D and Lee, J (1993) Visual reasoning: its formal semantics and applications. Journal of Visual Languages and Computing, 4, pp. 327-356.

Wang, D, Lee, J and Zeevat, H (1995) Reasoning with diagrammatic representations. In J. Glasgow, N. H. Narayanan & B. Chandrasekaran, eds, Diagrammatic Reasoning: Cognitive and Computational Perspectives, pp. 339-393. Cambridge, Mass: MIT Press.

Experiencing Interaction

Jonas Löwgren

First, a definition. *Interaction design* is to shape the use qualities of interactive systems. (The term »use qualities« is chosen to indicate something much broader than »usability«; more on this below.)

In an email some time ago, Paul introduced the categories of synthesis/analysis. I consider myself more of a designer than an analyst. Much of my scientific research has been performed by designing something in order to study aspects of it. My teaching is focused on supporting others in developing their design abilities. And so on. However, I find that I need analysis in order to do my job well. For teaching as well as for design practice, the most urgent analytical task for me right now is to develop a set of transferable concepts for talking about the use qualities of interactive artifacts/media.

The reason is simple. We need to understand good and bad interaction design. Transferable concepts are necessary to communicate and jointly develop that understanding (including, of course, revising and extending the concepts themselves).

The difference between use qualities and usability is one of scope. Usability is essentially about minimizing the amount of interference between the user and her task (yes, she is almost always assumed to have one, well-defined task). The user interface shall be made transparent, the interaction shall be made as error-free and efficient as possible. Historically, the usability concept emerged from the study of productivity applications in task-oriented contexts. This demarcation is still very much built into the concept and the scientific usability/HCI community. (Cf. an extended discussion in my review of a recent HCI textbook [1].)

Use qualities can, of course, comprise usability. But what are the use qualities of a computer game? It is safe to say that a typical usability perspective on a game yields no significant understanding of what makes the game good or bad. We need other quality concepts, the most essential one in this case being *playability*.

For other genres, other use qualities become the crucial ones. A few examples of possible genres and their essential qualities might include

- ubicomp: *fluency*
- interactive visualization: *pliability*
- narratives: *anticipation*
- technology-critical design: *para-functionality*.

I am not sure about the labels of the genres, partly because there is as yet no systematic discipline of IT criticism to help me draw the lines. But that is not important for the moment. My point is that the use qualities mentioned above are to a great extent *aesthetic*. In other words, they refer to the *user's sensual impressions and experiences*. This is precisely the reason I wanted to get involved in the aesthetic computing group. My goal is to produce better interaction design by better understanding the qualities of interaction; I hope that this group will prove a good place for developing and sharing that understanding.

Which finally leads me back to the scope of the group. The examples Paul provides and the student work he indicates all concern what computer scientists would call formal structures (finite state machines, entity-relationship diagrams, and so on). From my point of view, this is a very narrow

category. In my experience, users' understanding of information technology varies a lot in depth. For some people, the whole Internet is a formal structure even though the underlying model is not executable and unambiguous in the CS sense. For most people, a desktop PC as a whole is a formal structure.

It seems quite feasible to interpret aesthetic computing as *the aesthetics of computing*. If computing is understood in the everyman's sense of the word (information technology embedded in everyday life), then the aesthetics of computing refers to *the sensual/perceptual qualities of experiencing information technology*. Part of this information technology is the formal structures of computer science and mathematics; other parts comprise the rest of the software, hardware and »peopleware«. The implication is that we should apply aesthetic perspectives to information technology as a whole, not only to the domain of formal computer science.

Notes

[1] http://www.boxesandarrows.com/archives/002589.php

The Stone Age of the Digital Arts

Roger F. Malina

When Tim Binkley of the School of Visual Arts (SVA) contacted Leonardo with the idea of collaborating on the Digital Salon, we quickly accepted the proposal. This issue celebrates the many years of collaboration between SVA and Leonardo, a collaboration that has brought a new generation of digital artists to the attention of the international Leonardo audience. When Leonardo first started publishing the work of pioneering computer artists in the late 1960s [1] it was far from obvious that computer art would become the powerful means for contemporary expression that it has become today. Most new technologies do not prove to be suitable for art-making.

The change in the situation has been dramatic, seen from the point of view of the Leonardo editorial office. Our first book related to the use of computers in art---Visual Art, Mathematics and Computers [2], published in 1979---found a small but receptive audience. At that time, few art schools had programs that addressed the use of computers in art making and only such visionary centers as Gyorgy Kepes's Center for Advanced Visual Studies at MIT provided environments where artists could access the latest tools and devices. Our latest book to address the use of computers in art making is Lev Manovich's The Language of New Media [3]; it has now appeared in paperback and is reaching a large international audience. All major universities now have, or are starting, new programs in art and technology or art and new media. There are schools dedicated to the new art forms, such as the Academy of Media Arts in Cologne, Germany. SVA in New York now has one of the leading programs in the field.

In July 2002, Leonardo co-organized a workshop at the Schloss Dagstuhl Center in Germany on the topic of Aesthetic Computing [4]. The workshop was led by a computer scientist, Paul Fishwick [5], and brought together artists, engineers, designers and computer scientists. There was a new urgency. The discussion did not address how one could produce computer output that was considered to be of artistic or aesthetic interest. Instead, the heart of the debate was whether we could bring new ideas from art theory and contemporary art practice into computer science, engineering and design—and beyond this, whether we could re-imagine the internal structures and processes, the very metaphors of how computers are designed, made and used. Some of these are burning issues in computer science and engineering; there is an increasing interest in the personalization of computers to adapt them to individual use and preference. The computer is now a mass market device whose future use and evolution depends in large part on social acceptance and cultural desires.

The computer is still a very primitive device, and its cultural appropriation has barely begun. At an early ISEA conference, William Buxton, then of Xerox PARC, made an impassioned plea for re-imagining what computers could be. He compared the use of a computer keyboard as a human-machine interface with the musician’s use of a trombone or trumpet. A trumpet player uses eyes, ears, breath, saliva, body movement and touch to such an extent that the trumpet truly becomes a seamless extension of the artist's will. A jazz ensemble achieves a level of interactive creation that remains unmatched by any computer-mediated system. Even today's handheld devices are still foreign objects to the body and mind of the user. A number of experimental computer-machine interfaces and immersive environments—many developed by artists—now exist, but none are in large-scale production, nor do they achieve the jazz ensemble's seamless integration of human and tool in group work. The computer has not yet entered the biological age.

The artists at the Dagstuhl workshop included such pioneers in computer art such as Frieder Nake and Ernest Edmonds, but also artists from the more recent generation of practitioners such as Jane Prophet, Christa Sommerer and Jon McCormack. The early computer artists were either scientists

or engineers interested in creating artworks or artists working in close collaboration with engineers who translated the artists' ideas into concrete form. Today there are artists sufficiently well versed in contemporary computer science and engineering that they can carry out their own technical work or, as artists, lead multidisciplinary teams both to create artworks of artistic interest and even to develop innovative engineering and computer-science solutions or inventions. We again find ourselves in one of those special times in cultural history when artists, sciences and engineers because of their use of the same tool (in this case that of the computer) can share experiences and vocabularies, views of what problems might be interesting to solve and of which solutions would be considered exciting. Inevitably shared epistemologies, aesthetics and ethical systems will emerge from this process. The conditions are right for the emergence of New Leonardos.

Many of the New Leonardos will not be individuals but rather teams of several or many individuals working together. The Internet as a working environment facilitates many forms of cooperative, collective and collaborative work. The problems being tackled often require interdisciplinary teams that bring together disparate expertise from disciplines as diverse, for instance, as the cognitive sciences, nanotechnologies, biological sciences and cultural theory. Already, the open source approaches can point to successes in marshalling the creativity of large teams of geographically dispersed individuals on common projects. The institutional frameworks that foster such interdisciplinary work, and that often need to bridge the non-profit/for profit societal systems, are still in their infancy. A few pioneering programs, such as Roy Ascott's CAiiA-STAR, are exploring this education and research territory. Unfortunately early programs such as Xerox PARC's Artist-in-Residence program [6] and Interval Research Corporation are no longer in existence. Leonardo has recently launched a study under the leadership of Michael Naimark, with support from the Rockefeller Foundation, to learn lessons from the last 40 years of institutional experiments ranging from the early E.A.T. (Experiments in Art and Technology) program to today's leading institutions such as ZKM (Zentrum für Kunst und Medientechnologie), Ars Electronica, Banff Centre for the Arts and ICC (NTT’s InterCommunication Center, Tokyo). The time may be ripe for new forms of hybrid institutions that take advantage of the distributed strategies enabled by the Web.

Ironically, the very name "Digital Salon" has become an anachronism in itself. The rapid mutation of terminology is indicative that the heart of the matter has not yet been identified. The early practitioners of machine art, algorithmic art, electronic art, computer art, digital art, Web art and new media art [7] have shared few things except the use of the computer itself; their goals and practices differ widely, and they do not share a common aesthetic. In addition, many of the artists in new media also make use of many other technologies that are not in themselves computer based and are only incidentally digital. Steve Wilson in his Leonardo book Information Arts [8] has documented the growing array of areas of science and technology where artists are now occupying aesthetic territory. These range through all the physical, chemical, cognitive and biological sciences and include the whole array of nano- to macro-technologies. If the computer-based arts are still in their infancy, these other art forms are still at the point of conception. And yet their work is not peripheral to the development of the science and technology of the future, but is at the heart of the cultural imagination that creates the very desires motivating children to become tomorrow's scientists and engineers. Not only does the interaction between artists, scientists and engineers create the context for improved science and engineering, but different forms of science and engineering will merge from this period of cross-fertilization.

Scientists and engineers now work in realms that are almost totally outside of direct human experience. Astronomers work with forms of energy, such as gravity waves and neutrinos, that are not directly accessible to the human nervous system. Physicists and biologists work on such small scales that quantum effects and group phenomena emerge that are unknown on the scale that humans can experience directly. Chemists can now design materials with properties that are totally foreign to natural systems. Astronauts experience in zero gravity behaviors that are totally new to

human sensory and locomotive experience. And of course, computer scientists and engineers have provided a globally linked Internet system that provides such rapid feedback and diffusion of human interaction that we are entering a space of unknown social phenomena and behaviors. The human cognitive system did not develop with these new extensions of the human nervous system in place, nor while interacting with these environments and phenomena. So how do we develop our intuition about worlds and phenomena that are physically impossible for our human senses to experience directly? How do we build systems of values and systems of meanings, of ethics and aesthetics in this new epistemological landscape? Ken Goldberg, in his Leonardo book The Robot in the Garden [9], elaborates upon these issues in his exploration of "telepistemology"; the crucial question is no longer the location of the "ghost in the machine," but whether humans as primitive robots in this new foreign landscape can find a new orientation and vision for the human condition.

This intuition and cultural appropriation can occur if we create situations in which contemporary science and technology can be incorporated into artistic exploration (and vice versa), while recognizing the very different disciplines of the arts, the sciences and engineering. The creative process may be similar, but methodologies, goals, success criteria and institutional contexts are very different, and no doubt many areas of art, science and technology interaction will prove to be culturally sterile. The steam engine, railroad and telephone may have transformed the social landscape, but no significant new art forms emerged out of these particular technologies. Technologies of the moving image and cinema led to the media society we now enjoy, but there is no way of knowing ahead of time whether the new biologies and genetic engineering will lead to crucial art forms of the future until artists get inside them and make stories, tinker with the systems and re-engineer their context.

We are in the stone age of the digital arts, and it is likely that the future of the digital arts will have little to do with the digital and everything to do with the aesthetic and ethics that emerge from the new situation, just as the Renaissance was not about the technology of perspective but more about the new vision that emerged of the place of humans in nature and the future of human society. The New Leonardos face a task as daunting as those confronting Leonardo da Vinci and his peers; we can only hope that this special period of interaction between artists, scientists and engineers will change our vision of the world, and our place in it, as profoundly as did the Renaissance. The artists of Digital Salon are among those laying the groundwork for this cultural transformation.

References and Notes

1. Computer art was a subject of discussion from the earliest issues of Leonardo. See, for instance, Roy Ascott, "The Cybernetic Stance: My Process and Purpose," Leonardo 1, No. 2, 105--112 (1968); Richard I. Land, "Computer Art: Color Stereo Displays," Leonardo 2, No. 4 p. 335--344 (1969); Robert Mallary, "Notes on Jack Burnham's Concepts of a Software Exhibition," Leonardo No. 2, 189--190 (1969).
2. Frank Malina, ed., Visual Art, Mathematics and Computers: Selections from the Journal Leonardo (Oxford, U.K.: Pergamon Press, 1979).
3. Lev Manovich, The Language of New Media (Cambridge, MA: MIT Press, 2001).
4. See the seminar description at <http://www.dagstuhl.de/02291/>.
5. Paul A. Fishwick, "Aesthetic Programming: Crafting Personalized Software," Leonardo 35, No. 4, 383--390 (2002).
6. Craig Harris, ed., Art and Innovation: The Xerox PARC Artist-in-Residence Program (Cambridge, MA: MIT Press, 1999).
7. See, for example, the New Media Dictionary project, <http://www.comm.uqam.ca/GRAM/Accueil.html> (in French).
8. Stephen Wilson, Information Arts: Intersections of Art, Science, and Technology (Cambridge, MA: MIT Press 2002).
9. Ken Goldberg, ed., The Robot in the Garden: Telerobotics and Telepistemology in the Age of the Internet (Cambridge, MA: MIT Press, 2000).

Emergence and the Computational Sublime

Jon McCormack

As an artist, I am interested in exploring computation as a medium — as a raw material in which to define an artistic vision. However, to truly adopt this position involves a critical re-evaluation of many of the ideas that dominate computing and its related techno-scientific disciplines. It also requires a certain amount of faith: faith in computing as a concept and faith as to the range and scope of its descriptive power. Perhaps even, faith as to what might become possible that is not possible now — making this seem like a perilous position to be in.

Even on the simplest computers, the phase space of possible programs is vast 'beyond imagination'. To explore this phase space completely, even simultaneously on billions of the fastest computers ever built, would take more time than the universe is old. This vast space suggests a new kind of 'computational sublime'. But within such a vast space, most of the set of possible programs will be inoperative or uninteresting. The questions we might ask about this are: how do we find the interesting ones? How do we define the term 'interesting' and why should it be that only programs that fit such a category should be the subject of our enquiry? Might there be something to be gained from looking at the uninteresting ones as well? Can the concept of the computational sublime be different from other romantic narratives of the sublime?

Artists are looking to create works that are 'more than the sum of the parts', that lead to outcomes that they did not anticipate or expect. This led me to consider a long-standing debate in philosophy regarding the concept of emergence: the creation of fundamentally new properties. The 'emergence debate' has been renewed in recent times due to results from the 'complexity sciences' where computer experiments reveal 'emergent patterns and behaviours'. If artists want to create things that exceed the designers expectations, does the medium of computation (in theory at least) permit this?

People have used computers for many different purposes and in many different ways, but undermining all interpretations is the idea of representation — computers are symbol-processing machines that obey a deterministic set of rules. Symbols are 'given meaning' by the programmer, a process that is so transparent in programming it is rarely consciously understood or deeply considered. If we are to consider computation as a medium in which to work critically, then this issue of representation or mimesis becomes paramount.

I would like to draw open the question of thinking about computing in 'Kantian aesthetic' terms (as a matter of sensuous beauty or when a sensuous object or process stimulates our emotions, intellect, and imagination). I can see many ways in which this view may be limiting and problematic. If the concept of 'aesthetic computing' is not just to service or glorify the 'positive self-image of modern Western culture', nor to dwell as a techno-romantic adjunct to the rationalist ideology, then it needs be considered within a broader context. As an example of an alternative model, I would like to introduce some of Heidegger's thinking on aesthetics and being into the discussion.

Some References:

Coyne, Richard (1999), Technoromanticism: digital narrative, holism, and the romance of the real. MIT Press.
Dreyfus, H.L. (1991), Being-in-the-World : A Commentary on Heidegger's Being and Time, Division I, MIT Press, Cambridge, Mass.
Wolfram, S. (2002), A New Kind of Science, Wolfram Media, Champaign, IL.

ParaHuman: Enhanced Human Perception and Augmented Physics in Virtual Spaces

Richard K. Merritt

Literary and cinematic science-fiction has long offered a prescient glimpse into society's possible futures. Over the last several years computer gaming, console gaming and computer art have added to this complex network. It has been argued that recent advents□n physics modeling, coupled with socially challenging content, have increased the dynamism and viscerality of experiences in virtual spaces.

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The expanding computer game market (in 2001 U.S. consumers spent 9.4 billion dollars on computer gaming hardware and software, an increase of 43 percent from 2000) has challenged the market and cultural dominance of the box-office.□With this challenge we see an increase interrelationship, a dynamic exchange, between various forms of time-based narrative media. A chief focal point of these changes in the computer art, gaming, cinematic and literary science fiction and comic book media constellation, is the drive to augment and enhance human physical and perceptual capabilities.□nspired by the computational aesthetics of physics modeling in computer and console games as well as the dynamic content of comic books, cinema, and literary science fiction, individuals have been exploring the limits of human physical abilities as well augmenting those abilities through artificial means. With a keen eye to the aesthetics of virtual spaces(particularly games), augmented human abilities and an awareness of sometimes challenging content, humanity has been traversing the border between simulacra and the material. Consider the following:

- Are there inherent paradigms in physics modeling that inspire real world duplication?
- What cultural characteristics contribute to this?
- How are aesthetic considerations made in virtual spaces with respect to both physics modeling and challenging content?
- What, if any, are the inherent dangers of this amalgam of immersion, God-like powers, seduction and technological advancement?

Software as Material

Boris Müller

The term "aesthetic computing" seems to be a contradiction in itself. It describes two opposing worlds. The term "aesthetic" refers to qualities like "beauty", "pleasure", "emotional", "sensual" or "comfort". The term "computing" on the other hand, is related to expressions like "function", "features", "speed" or "efficiency". How strong is this contradiction? And is it possible to incorporate these two worlds?

Design has traditionally a strong association with aesthetics. Furthermore, almost all design disciplines have included the computer into the process of designing. So professional design is a discipline that deals both with aesthetics and computing.

However, most designers think of the computer as a tool, or in the case of Multimedia Design, as a medium, that enables them to create and to communicate their ideas.

Emerging design disciplines like Interaction Design or Computer Related Design on the other hand are not only using the computer, they question and explore the very structure of a computer system. Here, computer software is not only understood as a tool or a medium, but also as a material. The computer is not only used to produce aesthetic products, the very substance of computing is a material for aesthetic explorations.

In order to achieve an understanding of the aesthetic qualities of software, I suggest treating software just as any other material of creative practice. In the process of applying traditional art and design methodologies like exploration, modification and integration to software, aesthetic qualities of the material are revealed. As the main methodology of the arts is intuition, I believe it is important to learn an intuitive way of developing and working with software.

Ultima Ratio
- Software and Interactive Installation about coping with conflicts

Daniela Alina Plewe

For *Ultima Ratio* conflicts from real life and literature and art are reduced to their logical structures in order to process on the computer in several functional and dysfunctional modes. A decision-support system from the field of AI has been implemented and modified, which permits those conflicts to be remodeled as pro and contra argumentations.

The logical processes are displayed in realtime visualization as moving 3-D diagrams which simultaneously serve as interfaces. In the installation, these animationis were projected onto an overhead disk. The images follow the observer's view by means of a eye (head-) tracker, whereby the diagrams are distorted in accordance with the observer's changing perspective. A chorus of computerized voices provides a recitation of the dispute thus generated.

Ambivalence
Aesthetic experience is often the experience of contradictions. We encounter dilemmas, paradoxes or other forms of ambivalence in works of art, e.g. when a literary hero - in an aporetic situation - must make his tragic choice.

Example: Should Hamlet Kill Claudius?
Yes, since he wants to take revenge on Claudius who murdered Hamlet's father. No, because he believes that someone who is killed while praying goes to heaven. Fact: Claudius is praying. Therefore, do not kill him. What if Hamlet senses atheistic doubt (heaven?) in himself? Then yes, do kill.

Translation to the Prolog Code
Shakespeare, Hamlet Act 3, Scene 3

Hamlet. [approaches the entry to the lobby]
Now might I do it pat, now a' is a-praying-
Fact: praying(claudius)

And now I do 't [he draws his sword]and so a' goes to heaven,
Rule: in_heaven(Y) <- kills(X,Y), praying(Y)

Formalizing Conflicts as Argumentations – Symbolic Logic Approach
"Ultima Ratio" is based on a formalism developed as a nonmonotinic logic which permits to represent conflicts in the form of argumentations.The syntax includes facts and assumptions, two kinds of negation and exceptions to ruels.

The sytem evaluates the argumentations that lead to a conflict thereby checking the strength of the premises of the applied rules. The encoded intuitions are: facts weigh more than assumptions, from defeated informations shouldn’t be anything deduced and, strong negations (to know that x is not the case) are stronger than weak ones (not knowing if x is the case). Finally a decision within *UltimaRatio* is a recommendation for the conclusion of the least defeated arguement.

Functional and Dysfunctional Modes
With this setting various functions were designed, which - like the colours of a painting are meant to comment each other and sum up to one image.

CASCADES OF DOUBT - STRUGGLING AGENTS reconstructs the internal monologues of the heroes. With "change agent," users can influence these characters by changing the rules and assumptions which form the basis of the heroes' beliefs."Change world" revises the facts from which the program derives conclusions and generates logical alternatives to the original scenarios. "Remove conflict" offers suggestions as to how some conflicts could be avoided, in that other assumptions about the world are accepted as true statements.

This feature was inspired by a discontent about the medium film and it´s "behaviouristic" aspects. Documenting nothing else than moving materials (an actor´s skin e.g.) may not be the only means to display the activities of a "stream of consciousness".

The next function emphasizes an intersubjective perspective:

WAR OF CONVICTIONS - ARGUMENTS AS FORCES elaborates arguments as forces operating among and between particles of knowledge. The visitor selects a conflict from the databank, and the system provides him with the relevant arguments. A natural language interface for extending the database was planned for a final version.

CROSSOVERS - TRACING MOTIFS connects various plots and contexts according to their dramaturgical motifs. When rules occur in several contexts, the system creates a
link between them. Thus, the revenge-rule from "Hamlet" e.g. can lead to "Medea," in which a rival-rule comes into play just as it does in "Casablanca."

After having introduced with the functional modes the visual language, where each logical operation is represented by a visual action, now images were created which extend the actual logical functionality:

REASONING RUNNING WILD - COUNTERARGUMENTS FOREVER EVERYWHERE illustrates the omnipresence of possible doubts. The demand, that the logic may be based on "grounded arguments" was in this case neglected.
As an here "striving for the forbidden, the useless or the negative " is implemented. Instead of the infinite regress here notion of "deductive closure" may also have been an option. The next function meant to distort the logic itself:

INVERSIONS - NEGATIONS WITH NEGATIONS generated "logical Dada" with inverted facts
and rules. Does the complement of a logical inference also encompass the irrational? Can logics be distorted and functioning alternative deductive systems be implemented. This strikes also the question if other cultures reason diffrently or if they reason with the same logic but with diffrent premisses.

MODELLING VIRTUES - MODIFYING TOOLS OF LIFE Various human qualities, mental states and dispositions are interpreted in the framework of formalism and can be brought up on screen. Courage = live wrong, but win. despair = navigation in a reluctant environment.

The last mode features virtues within the system thereby focussing on the theme of a methodology of living. The rational reconstructions with the symbolic logic enhance the user to reflect the notion of rationality which may underly our decision making processes. Thereby the focus maybe broadened to a more general theme - an investigation into the methodology of living.

Credits: Michael Schroeder, AndreasRaab, Uwe Küssner, Manfred Stede et.al.
Further information www.sabonjo.de

Modeling the English Landscape
- gardening, the picturesque and the technological sublime

Jane Prophet

Over the last 10 years, working in collaboration with Gordon Selley, I have made art works that use artificial life programmes and fractal modeling to explore and challenge ideas about 'the natural' (in terms of both the body and landscape). TechnoSphere (http://www.technosphere.org.uk) made in 1995 with Gordon Selley is an alife world in which creatures engage with one another and email the human users that created them. Our users responses to this work say much about the shift in ideas about "Nature" and 'The artificial'. This project also runs in realtime 3D [1] at The National Museum of Photography Film and TV, in Bradford, UK.

More recent works, such as Decoy [2] made with Gordon Selley in 2001 use fractal mathematics to model idealised English Landscapes. Decoy is a screen based digital work reflecting on the politics of landscape, construction and ownership.

Drawing on works by painters such as Gainsborough and Poussin as well as the creations of landscape designers Humphrey Repton and 'Capability' Brown, Decoy consists of a series of animated digital 'paintings', displayed on plasma-screens, in which subtly evolving fractal landscapes are combined with photographic images of the views of the grounds of various country houses. This quintessentially English, Arcadian vista has entered the popular imagination as an embodiment of Nature and the Natural, yet it is almost entirely artificial in its construction. By combining these vistas with evolving simulated landscapes, Decoy unearths the artificiality of each landscape's past, either by returning the setting to a closer approximation of 'wild' nature, or by allowing the viewer to project ahead into the future, according to different growth and planting patterns.

I am interested in drawing connections between the painters and landscape gardeners of the 18th century and contemporary art and simulation, looking in particular at the use of the human body (viewer) in the landscape. The use of the human figure to determine a 'privileged viewing position' (or what w might also describe as using the human figure to define the viewing frustum of an actual landscaped parkland) is central to 18th century landscaping. The human body is also used as a 'measure' for scale when thinking of scale (to determine the sublime). During the aesthetic computing event I would like to show some of the works cited above and discuss a different definition of the sublime, drawing on fractal mathematics and current trends in biotechnology to debate a shift in our understanding of (human) scale.

Notes:
[1] http://www.cise.ufl.edu/~fishwick/dagstuhl/prophet_ac/technosphere.html
[2] http://www.cise.ufl.edu/~fishwick/dagstuhl/prophet_ac/decoy.html

Position Statement on Aesthetic Computing

Steven Schkolne

I have been asked to write a position statement on aesthetic computing, so here it goes: I feel the term aesthetic computing is really vague. Both of the terms are really broad, and there has not been a lot of time for a community to develop (outside of the Dagstuhl seminar group I know of none). I could instead talk about what I think it *should* mean, but I have no need for such a term. Nor do I feel it's possible to neatly collapse the greatly varied things that were presented at Dagstuhl into a concise definition. For my thoughts on issues of beauty + machines, check out my images, interactive media, lectures, and sound compositions.

http://schkolne.com
http://essetesse.com

Aesthetics in interface design

Angelika Schulz

Interfaces are built by visual, sometimes as well by audible elements (e.g. text, colour, background, pictures, buttons, sound). They should be designed in a way that users more or less immediately understand their function and the way they should be used (usability criteria such as transparency and ease of use). Design is form and form not only transports information about function, not only activates or prepares action: the interface also conveys information that can activate aesthetic perception. Aesthetic perception plays with forms and their relation and thus might distract from immediate identification of function and thus from action.

What interfaces carry beyond their function might be called "aesthetic surplus". This "surplus" is the result of design activity (through "form-giving") but is also connected to the user (by perception). The often neglected aesthetic part of interface design can - as already mentioned above - distract perception but it might as well direct it (good design can lead to that).

Similar to the furniture of an apartment, to a magazine or to clothes for instance, an interface might show social or cultural patterns that work for a user as a means of identification. It is this aesthetic quality of an interface as a whole that influences the perception of an object or an application in a positive or negative way and might therefore have an effect on functionality. Maybe we can talk as well about style.

Even if style is independent from the pragmatic function of an interface, it is part of its "message". Style can be emotional, it can motivate, create identification and connect a product (and the user as well) to a specific historical, cultural and social context. As Bürdek (1991) puts it, the aesthetical means of design vary between radical-analytical and emotional-sensual design/style. Or, to choose examples from the product design area here as metaphors, between "Bauhaus" and "Memphis".

Questions remain: Out of what does aesthetic quality really consist? Should we more clearly talk about style? Is it then better to talk about the aesthetic qualities of an interface? How could they be defined?

References

Bürdek, Bernhard (1991): Design: Geschichte, Theorie und Praxis der Produktgestaltung. Köln: DuMont.

Empirical Studies of Aesthetics and Usability

Noam Tractinsky

My interest in studying the aesthetic aspects of human-computer interaction (HCI) aroused serendipitously during ACM's CHI conference in 1995. Traditionally, the field of HCI has been led by task-oriented theories. The ultimate goal of the human-computer interaction according to these theories is efficient performance, usually operationalized in terms of minimizing execution times and errors. "Usability" is perhaps the most popular concepts advanced by HCI researchers and practitioners. Within this paradigm, aesthetic considerations are either ignored or relegated to a secondary role under the condition that they do not compromise the system's usability. This viewpoint was quite acceptable to me until I attended a short presentation at CHI '95 by Masaaki Kurosu [1]. Masaaki studied the association between the interface's adherence to standard usability guidelines and users' perception of the design's usability. It turned out that following researchers' guidelines had little effect on whether users evaluated the design as usable. Interestingly, though, users' perceptions of usability were strongly related to their evaluations of the beauty of the interface. These intriguing results enticed me into running a series of experiments on the aesthetics of interfaces.

The results of our experiments suggest that aesthetic aspects of computer applications play an important role in how users evaluate and experience the system, not unlike similar phenomena found in the fields of social psychology and marketing. We corroborated findings about the relations between usability and aesthetics across cultures, and extended the results beyond the first impressions generated by the system. The findings of a recent study point towards a multidimensional view of aesthetics, which may explain, in part, the relations between usability and aesthetics that were observed in earlier studies.

Our studies thus far have examined aesthetics from a relatively narrow and static viewpoint. The insights gained are still tentative and incomplete. Capturing, measuring, and manipulating more elaborated and dynamic models of the aesthetic/affective user experience would be a great challenge for future research in aesthetic computing.

[1] http://www.interq.or.jp/tokyo/kurosu/kurosu.html