Open Competition 2004 Application

1. Title

1.a. Project Title: Exploring the Boundary Between Visual Art and Digital Technology
1.b. Project acronym: BOVIARDITE
1.c. Principle investigator: Prof.dr. L. Hardman

2. Summary

2.a. Summary. The aim of this project is to provide the theoretical basis and basic technology for the new type of process model that allows the development of a software environment that supports the real-time generation and adaptation of visual media. Based on our formal framework we will investigate how we can integrate ideas from different disciplines into one paradigm for visual electronic art. The research methods used reflect the interdisciplinary approach, bringing together different disciplines on the boundary between visual art and computer science. Our target user group is video artists, since these pioneers push tools over their limits, while at the same time requiring high-end interfaces. The results of this new research direction stimulate and reshape work on the semi-automated generation of digital media with an emphasis on tools that support the generation of expression-based interactive media.

2.b. Samenvatting. Het doel van dit project is een theoretische basis en technologie op te zetten voor een nieuw type procesmodel voor de ontwikkeling van een software omgeving, zodat real-time generering en aanpassing van visuele media ondersteund kan worden. Gebaseerd op ons formeel framework zal onderzocht worden hoe ideeën vanuit verschillende disciplines geintegreerd kunnen worden in een paradigma voor visuele electronische kunst. De onderzoeksmethoden die gebruikt worden reflecteren de interdisciplinaire benadering, waarbij verschillende disciplines op het grensgebied van visuele kunst en informatica samengebracht zullen worden. Onze gebruikers zijn videokunstenaars die al sinds jaren de uiterste grenzen van deze techniek opzoeken en hun wensen voor wat betreft de interface voortdurend bijgesteld willen zien. De resultaten van dit onderzoek stimuleren en verleggen het werk op het gebied van semi-automatische generatie van digitale media. De nadruk in dit onderzoek ligt op tools die de generatie van expressieve en interactieve media ondersteunen.

3. Classification

Informatica: 5.4 Multimedia (MM), 5.6 Intelligent Systems (IS)

4. Composition of the research team

Nam	Research interest	Institute	Hours per week
Prof.dr. L. Hardman	Automatic generation of user-tailored hypermedia presentations and document models for hypermedia and synchronized multimedia on the Web.	CWI and TUe	2
Dr. J.R. van Ossenbruggen	Synchronized multimedia on the Semantic Web, automatic generation of user-tailored hypermedia presentations	CWI	4
Dr. Remko Scha	Image generation, gestalt perception and visualization, auditory perception and music, artificial interface design	UvA and IAAA	1
Anne Nigten	Interdisciplinary research and development, resulting in models for collaboration amongst artists, engineers and computer scientists.	V2_	4
Michiel W. Kauw-A-Tjoe	Semi-automated generation of interactive electronic art	CWI	40

Financial means are required for the Ph.D. student (4 years). Dr. J.R. van Ossenbruggen will act as the daily thesis advisor and prof.dr. L. Hardman will act as the official promotor for the Ph.D. student for whom financial means are requested in this proposal.

5. Research School

Dutch research school for Information and Knowledge Systems (SIKS)

6. Description of the proposed Research

6.a. Problem description and research questions

As technology and research on environments that facilitate the creative processes within semi-automatic generation of interactive electronic art are still in their infancy it is now the right time to explore new paths. The newness of the field, however, requires a short introduction to the problems to be faced.
Since the onset of digital technology, scientists and artists alike have applied computers to push the boundaries of art. Especially during and after the Internet boom, digital media have undergone exponential growth both in terms of popularity as well as in level of sophistication. Whereas broadcasted audiovisual content is determined and created by a small group of people and is practically non-interactive, *new media* offer advanced editing and scripting capabilities, multimedia formats and communication standards, interactive participation, high accessibility by non-professional users and real-time rendering if sufficient hardware is available.
In this context, the electronic art community has undergone rapid growth. However, as is stated in [15], there is still a lack of appropriate tools to develop high-end artistic content using digital media:

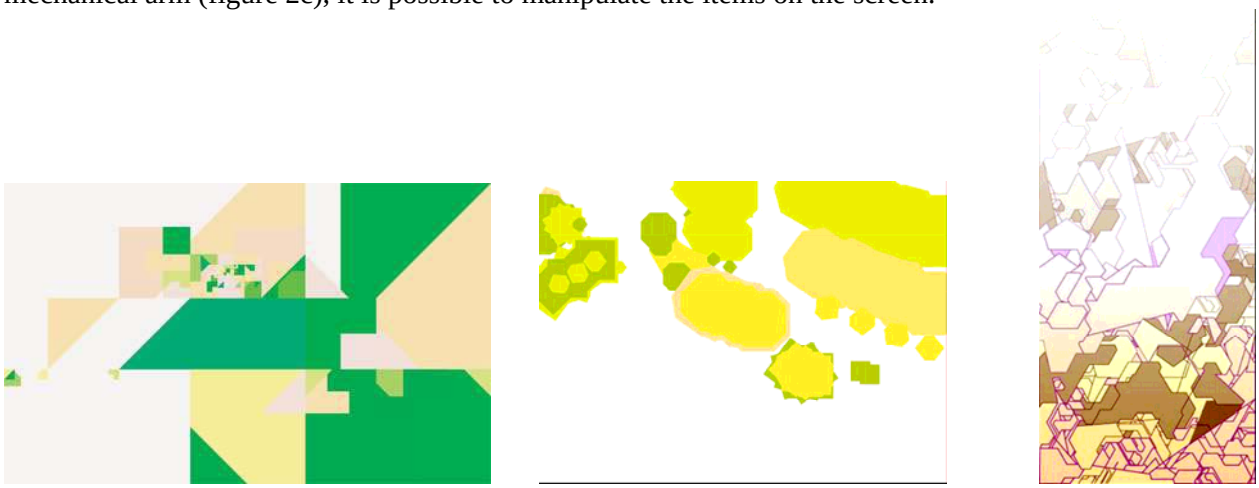
> *"Defining what makes an appropriate environment for making digital art is less easy [...]. In the digital domain of today, the huge variety of choices and standards, as well as the inherent difficulty of using some kind of hardware and software, makes it particularly complex. At this time, it is hard to arrive at a stable, all-purpose environment that meets the requirements of every user."*

Our goal is to establish a new paradigm for the creation of visual electronic art to bring together the different disciplines on the boundary between visual art and computer science.
Computers have been applied in different existing artistic contexts, such as music, design and architecture. We will focus on visual aspects of electronic art. Since vision and sound are the two most common modalities in human computer interaction, we are thus primarily excluding audio information from our research. The two main dimensions that distinguish digital media from traditional media, such as canvas, photography and film, are *generativity* and *interactivity*. Our target domain is therefore that of generative, interactive visual media.
Generative or *algorithmic* art is centred on the idea that the artist writes computer software, which generates the actual artwork when the software is run. Algorithmic art can therefore be described as a form of *meta-art:* in contrast to most traditional art, where the artistic value of a work is ultimately defined by the end result, in the case of algorithmic art the creation process itself is also considered highly significant. According to the categorization of Scha developed at the ILLC [12], there are four basic approaches to algorithmic art:

- the *structural* approach,
- the *optimisation* approach,
- the *emergence* approach and
- the *data-visualisation* approach.

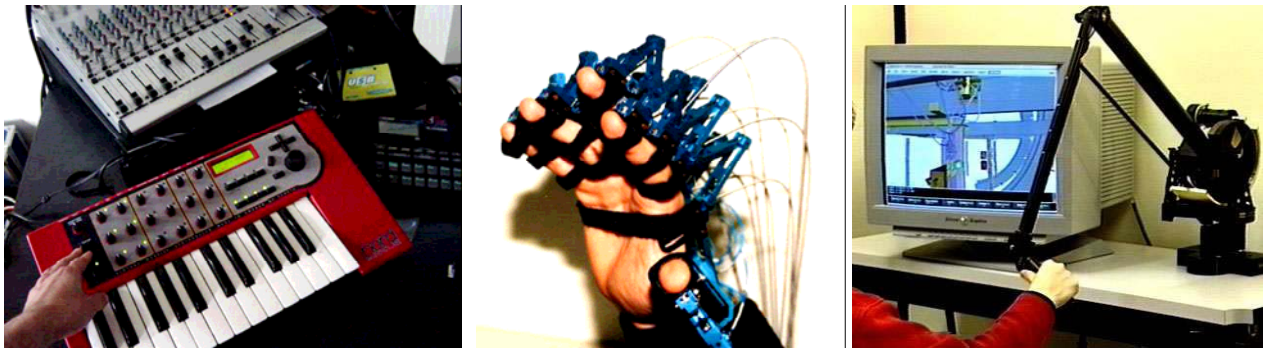
The structural approach is based on ideas of linguistics and logic. A set of graphics defines the *image language*, while the relationships between the graphics form the *visual grammar* or *algebra* [3,4]. The optimalisation approach defines a model for the desired outcome, after which the rules for constructing this outcome are specified. Often a model of the style of an existing artist, for example Mondrian, is used. Each time the algorithm runs, a new composition is constructed. Optimalisation lies in the fact that after several runs the best compositions are selected according to certain evaluation criteria (for example the taste of an observer), after which the construction rules are adapted slightly and the algorithm is run again. The emergence approach is based on an idea similar to that of Artificial Life (AL), a field that studies lifelike behaviour through the modelling of worlds with simple rules and relationships. In AL typically the dynamics of ant colonies and single cell organisms are modelled. It is relatively easy to translate emergent behaviour to visual output, resulting in a higher-level generation process, which is not directly explainable by looking at

the underlying rules. Finally, data-visualisation is focussed on the translation of information structures such as databases or the Internet to an artistic form. Data entities and the relationships between them are mapped to a dynamic environment, for example visually. The way the digital archive evolves is seen as symbolic for the structure of a society in which information plays an increasingly important role [2].
While an ideal theoretical model of visual generative art should be able to cover all these approaches, we will initially focus on modelling the structural and emergence approaches. The structural approach corresponds most directly to the candidate's master's research [10] (see figure 1a and b) and affiliated work (figure 1c), while the emergence approach is the next logical step from a structural to a more time-based model. We will incorporate relevant optimalisation and data-visualisation aspects later, concentrating especially on evolutionary computing and data-set manipulation techniques.
Next to generativity, interaction forms an important added dimension of new visual media over traditional visual media. By default, interaction with the computer takes place through the keyboard, mouse and screen. However, in the context of artistic expression it is often desirable to be able use the tools of expression more intuitively. Our model for interactive generation should thus also consider other, non-traditional input devices. The *MIDI* standard, for example, was originally developed for the communication of musical data. While available MIDI devices are usually aimed at making music, it is also possible to use them to manipulated graphics. This is done by mapping the keyboard to visual parameters such as colour and luminosity instead of tone and timbre. There is a wide range of available MIDI hardware (figure 2a) and some devices have been designed with this specific goal in mind. C*omputer haptics* enable interaction with a digital environment through touch [14]. By wearing so called data-gloves (figure 2b) or rotating a mechanical arm (figure 2c), it is possible to manipulate the items on the screen.



(a) isometric shape composition *(b) shape pattern composition* *(c) rendered composition*

Figure 1: structural generative art



(a) assignable MIDI keyboard *(b) haptic glove* *(c) haptic arm*

Fig. 2: some examples of input devices

Research questions

This research will be located at the nexus of art, science and technology. The aim of this research is to provide a formal model that joins research and common practice in visual art, software engineering and physical interaction, which should lead to the development of an overall paradigm for visual electronic art. The research questions we will try to answer are:

1. What are the relevant dimensions of art, media generation and interaction technology, focussing on the visual modality?
2. How can we translate our findings into a formal framework and eventually into a paradigm for visual electronic art?
3. How can this contribute to the practice of machine assisted composition and interactive performance in such a way that the possibilities of expression in the visual arts through new media are expanded?

Expected results of the research

The results of this new research direction stimulate and reshape work on:

1. the semi-automatic generation of expressive and interactive electronic art,
2. the development of tools that semantically support the artist during all stages of the art generation process ,
3. the development of ontology technology as then the representation of processes and context can be represented,
4. the domain of knowledge presentation in general as solutions to the representation of the form, structure, function, and effects of data finally allows to address *aesthetic* dimensions of data,
5. the automation of digital media production and reuse and
6. the automatic visualization of dynamic information in interactive environments.

Thus, the work of this proposal works as a catalyst for various research directions within the domain of multimedia computing.

6.b. Proposed methodology to be used

The research methods used reflect the interdisciplinary approach. The overall methodology exercised in this research is to identify applicable processes in existing methodologies for art generation and knowledge processing, mainly from the humanities (e.g. phenomenology, semiotics, hermeneutics, and interactive media theory, history, and anthropology) and cognitive science and combine those with process approaches from various fields in computing science (e.g. evolutionary computing, HCI and AI). The aim is to develop a formal model by implementing an integrated software environment. This should function as a test bed to analyse and evaluate the relevance of the different dimensions of visual electronic art. Practically, this involves installing a hardware set-up for which software can be developed that integrates the different aspects of this research.

The development of a prototypical environment as proof of concept requires, however, that we get a better understanding of the domain. We seek the help from practitioners from the domain and rely here on our collaboration partners at the Institute for Unstable Media (V2_) in Rotterdam. The electronic art community is global, but well organized. Artists keep up with the latest developments through mailing lists, events and institutions. To establish a firm embedding in the community, we will collaborate with V2_ in the form of an internship of the PhD student. V2_ has participated in numerous national and international new media art projects. In addition, V2_ has its own laboratory at which a varying group of art students and scientists do research.

Having a clearer idea of the possibilities and limitations of current new media art, we will make an in depth analysis of research areas related to electronic art in cooperation with professor Scha at the *Institute for Logic, Language and Computation* at the University of Amsterdam (UvA). We plan to take material from professor Scha's lectures on “Algorithmic Art and Artificial Intelligence” as a starting point to survey a wide range of relevant topics. The first line of investigation focuses on relevant literature on electronic art [5,6,7,8,11,12,13] and related areas, such as human-computer interaction and traditional art forms, such as fine arts, film and animation [1,9]. At the end of this investigation a theoretical model will be designed that provides the formal framework to base our further research on, namely the development of an integrated software environment which can serve as a tool to create visual, time-based interactive art.

To establish what technologies exist to base such a system on, we will research existing platforms and libraries such as MAX/MSP and Java 2D/3D. We will develop the prototype system at the INS2 department of the *Centrum voor Wiskunde en Informatica* (CWI) in Amsterdam. This group does extensive research on the application of new media technology in several domains, such as the semantic web and the automatic generation of multimedia presentations. Therefore it has the required expertise to give this project a sound technological background.

The usability of the prototypes is evaluated empirically, based on user test with respect to usefulness of representation structures for real world tasks. The empirical study will be performed on artists and researchers working at V2_. Additionally, we also evaluate the usefulness for the visualisation of structures and processes in the user interface. The gained results subsequently improve the design of representation

structures, processes and graphical user interface.

6.c. Innovation

This project is innovative on several counts. It is by definition interdisciplinary. Relevant scientific domains include artificial intelligence and computer graphics. The time-based generation and interaction aspects are characteristic for a wide range of new media applications such as multimedia presentations and games. Formal time-based and narrative ideas can be found in other artistic disciplines such as music and traditional film and animation. The artistic value of electronic art is often related to other existing art movements, such as modern art and meta-art.

Electronic art by itself is innovative because state-of-the-art technology is applied in a creative way. Artists, who are often not experts or scientists, explore the boundaries of what can be done with the tools available to them. This often leads to unconventional new approaches.

Practically, this research could push the scientific and technological state of the art to its limits by laying a formal basis for a new area where art, science and technology meet. In addition, it could help us better understand the requirements of a specific group of end-users, the ones interested in creative production of digital content. Most research in computer graphics, multimedia and user interface design that is partly driven by artistic motivations tends to focus mainly on the expressiveness of the models, the performance of the algorithms or level of realism created for three-dimensional interfaces. However, laying less emphasis on such practical criteria and more on artistic ideas would require a paradigm shift from an analytical design perspective to one that is based on expression and active involvement. The research of such a new paradigm could ultimately lead to the development of better tools for expression.

That art and technology are intrinsically related can be understood when one considers that the quality of electronic art is often determined by the extent to which the technology lends itself for artistic expression. Artists will exploit the available tools to their limits. Through new developments the limits of what one can do with the current technology are constantly redefined. This research should be situated at this front-line of innovation.

Relevance for science, technology and society

Over the past century, technology has had an increasing influence on almost every aspect of society. As was pointed out before, the role of the computer has steadily shifted from purely a “number-crunching” machine to a tool that supports human tasks in many different application areas. However, there is still a mentality gap between the computer science and the creative community: computer experts tend to approach art in a formal, exact way, while many artists find it difficult to adapt to the rigid, procedural nature of machines. As we discussed in section 6d, changing the research focus could lead to a paradigm shift in which active involvement and creative expression are emphasized. However, to realize such a shift one requires participants from the scientific, technological and artistic communities that really understand each other's language and respect the different goals and agendas involved. This research will be centred right in the middle between these three groups, thus providing ground for an active cooperation between experts from multiple disciplines and different institutes.

Visual arts are but one example of a domain where creativity and technology meet and are obviously part of a larger context. The more generalized results of the research of this particular domain will also contribute to the understanding of other fields, including commercial applications such as advertisement and web site design.

Although this research is strongly focused on supporting creative ideas, it is also scientifically founded and relevant. The underlying theoretical model should be sound: on the one hand, it should be general enough to cover the relevant dimensions of algorithmic art systems. On the other, it should be detailed enough and the scope should be clear so it can be used to build concrete implementations. It should be possible to test such a prototype tool in an experimental set-up with a target group of experts and end-users to see if the ideas on which it is based correspond to reality.

6.d. Relationship of proposed research to research carried out elsewhere

see 6.e.

6.e. Integration of the research in ongoing work of the research team

The three main parties are already involved with investigations in the direction of the proposed research.

The **Multimedia and Human-Computer Interaction group** (INS2) at CWI has been involved with the development of models and authoring systems for multimedia and hypermedia since the early 1990’s. Results of this work include the Amsterdam Hypermedia Model, contributions to the W3C SMIL 1.0, SMIL 2.0, and XHTML recommendations, the hypermedia authoring system GRiNS, and the CWI spin-off

company Oratrix. Members of the group, namely Lynda Hardman, Jacco van Ossenbruggen and Lloyd Rutledge, have been active in W3C's HTML and SYMM Working Groups and ISO's MPEG7 DDL Working Group (Frank Nack). Current research projects can be seen here: http://db.cwi.nl/projecten/thema.php4?themanr=6&type=projects

Remko Scha (UvA) is a internationally acclaimed researcher on algorithmic art and new media. His ongoing research on automatic image generation, gestalt perception and visualization, as well as on artificial interface design is described here: http://www.iaaa.nl/rs/science.html#research

V2_Lab is a workplace for artists, scientists and technicians that emphasizes meeting and exchange among the various disciplines involved in the realization of electronic media art productions. V2_Lab stimulates research and development in electronic art by providing technical and productional support to artists. V2_Lab also participates in technical research projects aimed at stimulating the flow of knowledge and ideas among different disciplines. V2_Lab offers a forum in which knowledge from various disciplines and professions can be collected. It aims to combine the knowledge from this interdisciplinary forum and expertise with concepts in the field of unstable media. Their work can be studied here: http://lab.v2.nl/home/index.html

7. Work Programme

Year	Research activities
2005	Internship at V2_ to get experience in an artistic environment. Collaborate with different artists that make use if computers to see how they apply existing technology and overcome or surround the problems they face. Literature study at the department of Remko Scha for scientific embedding of project. Topics will include artificial intelligence, computer graphics, modern art, kinetic art, music composition, animation, semiotics, multimedia and games. Make first conceptual model for visual electronic art with focus on the dimensions generativity, interactivity and time-space behaviour.
2006	Do research on equipment, such as haptic interfaces, MIDI-devices and computer software. Study of existing Max/Jitter and PD environment and Java Media, 2D and 3D libraries. Research e-art of new media developments. Design and development of prototype system to find out constraints and problems. Development prototype tool based on the detailed model.
2007	Finish implementation of prototype software environment. Make experimental set-up to test model through the implemented tool on a group of expert and end-users. Collect test data. Write down the basic structure of thesis.
2008	Round up technical development and extract experimental results. Write Phd thesis.

Though the PhD students is encouraged to plan his own research schedules, which is understood as a part of his skill improvement schema, a weekly group meeting is organised to allow for quick strategic or topic-related discussions if required. Two larger events (around two days) per year are scheduled for in depth discussions between the members of the research team and associated institutes.
The Ph.D. student is also supported to frequently visit related research groups. This not only fosters his intellectual view on his reseach in form of research and group organisation but also makes him and his ideas visible – an essential criteria for becoming a member of the next generation of leading researchers in the field. The Ph.D student will also be encouraged to assist in setting up workshops, tutorials and special sessions at the relevant conferences which again increases his visibility and naturally the one of the research direction – the same applies to the other members of the research team.

8. Expected use of Instrumentation

The equipment provided by the host institution as well as the associated institutions will be sufficient.

9. Literature

[1] Bordwell, D., Thompson, K., *Film Art – An Introduction*, fifth edition, The McGraw-Hill Companies, Inc., ISBN 0-07-006634-5, 1997.

[2] Brouwer, J, Mulder, M., *Information Is Alive – Art And Theory On Archiving And Retrieving Data*, NAI Publishers, ISBN 90-5662-310-9, 2003.

[3] Cha, M.Y., Gero, J.S., "Shape Pattern Representation for Design Computation", in progress.

[4] Chase, S.C., "Representing Design With Logic Formulations of Spatial Relations", *Workshop Notes, Visual Representation, Reasoning and Interaction in Design*, Fourth International Conference on Artificial Intelligence in Design, Stanford University, June 1996.

[5] Cohen, H., "Parallel to Perception: Some Notes on the Problem of Machine-Generated Art", *Computer Studies*, IV-3/4, 1973.

[6] Davenport G., Mazalek, A., *Dynamics of Creativity and Technological Innovation*, Digital Creativity, Swets and Zeitlinger Publishers, 2003.

[7] Fleischmann, M., et al., "Digital Sparks - Ein Wettbewerb Studentischer Medienprojekte", Konferenzband EVA, Elektronische Bildverarbeitung & Kunst, Kultur, Historie, Berlin, 2003.

[8] Holzman, S.R., *Digital Mantras – The Languages Of Abstract And Virtual Worlds*, The MIT Press, Cambridge, Massachusetts, ISBN 0-262-58143-4, 1994.

[9] Kandinsky, W., *Point and Line to Plane*, Trans. H. Dearstyne and H. Rebay. New York: Dover, 1977.

[10] Kauw-A-Tjoe, M.W., *Generation of Abstract Geometric Art Based On Exact Aesthetics, Gestalt Theory and Graphic Design Principles*.

[11] King, M., "Computers and Modern Art: Digital Art Museum", *Proceedings of the Fourth Conference on Creativity & Cognition*, Loughborough, UK, pp88-98, October 2002.

[12] Material for a course by Remko Scha with contributions by Jos de Bruin and Jochem van der Spek. Curriculum "New Media", Faculty of Humanities, University of Amsterdam (Fall 2001, Fall 2002, Fall 2003), http://iaaa.nl/cursusAA&AI/.

[13] Snibbe, S.S., Levin, G., "Interactive Dynamic Abstraction" in *Proceedings of Non-photorealistic Animation and Rendering (NPAR 2000)*, ACM, Annecy, France, 2000.

[14] Srinivivasan, M.A., Basdogan, C, "Haptics in Virtual Environments", in Computer Graphics Vol. 21, Nr. 4, pp 393-404, 1997.

[15] Candy, L, Edmonds, E., "Explorations in Art and Technology", Springer-Verlag, London, ISBN 1-85233-545-9, 2002.

10. Requested Budget

Financial means are required for the Ph.D. student (4 years).

Position Duration	OIO	Other stuff
1st – 4th year	157683 €	n. a.
Benchfee	4538 €	n. a.
TOTAL	162221 €	