

Performing Digital Aesthetics: The Framework for a Theory of the Formation of Interactive Narratives

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While the enhancement of participatory technologies over the last decade has converted viewers of information into producers of a digital world, less attention has been given to the role played by narrative in structuring our interactions with the digital. As digital technologies intersect with our movements, decisions and responses with increasing ubiquity, the meanings of these transactions coalesce as eventful and episodic transactions that structure our communicative experience in the form of interactive narratives. Based on previous Australian Research Council funded research undertaken at the iCinema Research Centre at The University of New South Wales, this paper sets out a framework for theorizing the emergence of interactive narratives in our encounters with the digital, particularly in immersive and cinematic art installations.

The way that narrative is currently understood in interactive applications, whether in terms of new media art, social networking, gaming, or simulation and training applications, remains wedded to narrative forms, structured into conventional branching or multi-linear forms. Here interactive narrative is predominately understood as a formulation of old media practices—embodied by the narrative conventions of, for instance, the novel or the cinema—reapplied in the context of new media, with the user positioned as interpreting a meaningful narrative via the navigation of largely pre-scripted paths through data. However, as theorists such as Henry Jenkins [1], Lee Siegel [2] and Matthew Fuller [3] have foreshadowed, the advent and exponential growth of a participatory, convergent and networked culture over the last few years is creating new types of narratives that blur the line between reception and performance, establishing new kinds of intelligent information use.

In May 2009 YouTube announced on its blog that 20 hours of video were being uploaded to the site every minute, and in 2008 Google announced that the number of unique web pages

it indexes had reached 1 trillion.

The question is, how do the necessary links and relationships within this mass of data interact to affect its coherent and aesthetic use?

How do we explain which agencies combine to determine what is *meaningful* in the way we experience our interactive encounters with a technologically mediated world and distinguish them from the production of what Marcus du Sautoy

quoting Poincaré calls “sterile combinations” [4]? Our previous research indicates that it is not the data itself that “represents” its meaning, affect or utility. Rather its meaning flows interactively as data is generated, recalled and reassembled by users. Here cognitive emphasis is placed on practical reasoning in the user’s engagement with the relational structure of new media and the possibilities it provides for the activation of new information [5]. Interactive narrative emerges as a meta-structure that transfers meaning through the experience of interactive episodes with the data. In a McLuhanesque sense, the message is unfolded from, or actualized by, the organizational structures of the medium. For instance, it is not an image itself that embodies a particular meaning in interactive contexts, rather it is the process involved, both technological and human, in actuating the image that constructs its meaning or usefulness. Building on Niklas Luhman’s theory of art as a communicative and social system [6], we can say that our perception of digital information is linked directly to the digital communication system, its network of relationships and its associated interactive practices. As such, interactive narrative, as a process of episodic interactive events, is a processual encounter in which the user, rather than simply a “reader” of a textual narrative, is an active participant in the communication system that is central to the coherent, meaningful and aesthetic use of this information in digital settings.

This paper sets out three functions of interactivity and indicates the way these functions can be assembled into a relational schema providing a framework for the future elaboration of a relational theory of interactive narrative. In order to further the understanding of our processual and meaningful encounters with digital technology, future research into interactive narrative will benefit from the application of a framework expressing hypothetical relations between key functions that contribute to the organizational meta-structures from which the narrative is composed. The proposed framework is formally

ABSTRACT

Interactive narratives are inextricable from the way that we understand our encounters with digital technology. This is based upon the way that these encounters are processually formed into a narrative of episodic events, arranged and re-arranged by various levels of agency. After describing past research conducted at the iCinema Research Centre at the University of New South Wales, this paper sets out a framework within which to build a relational theory of interactive narrative formation, outlining future research in the area.

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Article Frontispiece. Neil Brown, Dennis Del Favero, Matt McGinity, Jeffrey Shaw and Peter Weibel, *T_Visionarium*, stereoscopic interactive and immersive installation, 2008–2010. (© Dennis Del Favero)

designed to capture the bottom-up processes by which “things” actuate from a field of conditionings, from the workings of an assemblage, or from the protocols of a system. Such a bottom-up approach to theory development takes into account the various levels of agency at play in our encounters with digital technology and is ideally adapted to explaining the emergent and relational character of the field.

Previous research conducted at the iCinema Centre has identified the agency of artists, computer programmers and users, along with the agency of things such as intelligent systems, navigational conventions and commercial constraints. Earlier work has also explored the functional contribution of a number of these agencies experimentally. While not exhaustive, these levels of agency, in one way or another, initiate systematic processes that contribute to the interactive narrative system, providing the conditions for the narrative to emerge. As such, all of these agents need to be thought of in the same manner, regard-

less of whether these are human or non-human [7]. Throughout this discussion our position on digital aesthetics and interactive narrative is founded upon the notion that aesthetics are not confined to judgments over qualities passively experienced at the visible level of the screen, but also include the usually invisible layers of software and the interactive processes and relationships formed between the levels of agency that *perform* the interactive artwork [8].

Following in the wake of the transcendental empiricism set out by Gilles Deleuze [9], the framework established in this paper is one that allows for the conditions, organizational structures and processes that elucidate the “becoming” of interactive narrative. In other words, this approach privileges the field from which events, objects and “things” come into being [10]. This line of thought enables us to understand diverse things such as cities, societies and people as well as technology and art, not by their appearance or their allotted role but rather by the invisible set of organizational

structures, rules, laws and protocols and their interaction with other individuals that directs their becoming [11]. For Deleuze there exist two planes of events developing simultaneously: On one level are actual events, as real events that are the solutions to particular problems, and on the other level is what he terms the virtual, a set of ideal events embedded in the condition of the problem [12]. To understand how any collective, assemblage or machine, including the digital machine, is able to produce new or novel information we need to understand the virtual as a field of emergence, a field or grounding that conditions the manner in which novelties actualize [13]. Following this, the framework set out here hopes to tease out the *processes* of agents, investigating predispositions, underlying beliefs and protocols—in short, investigating the virtual aspects that provide the grounding from which an interactive narrative takes form.

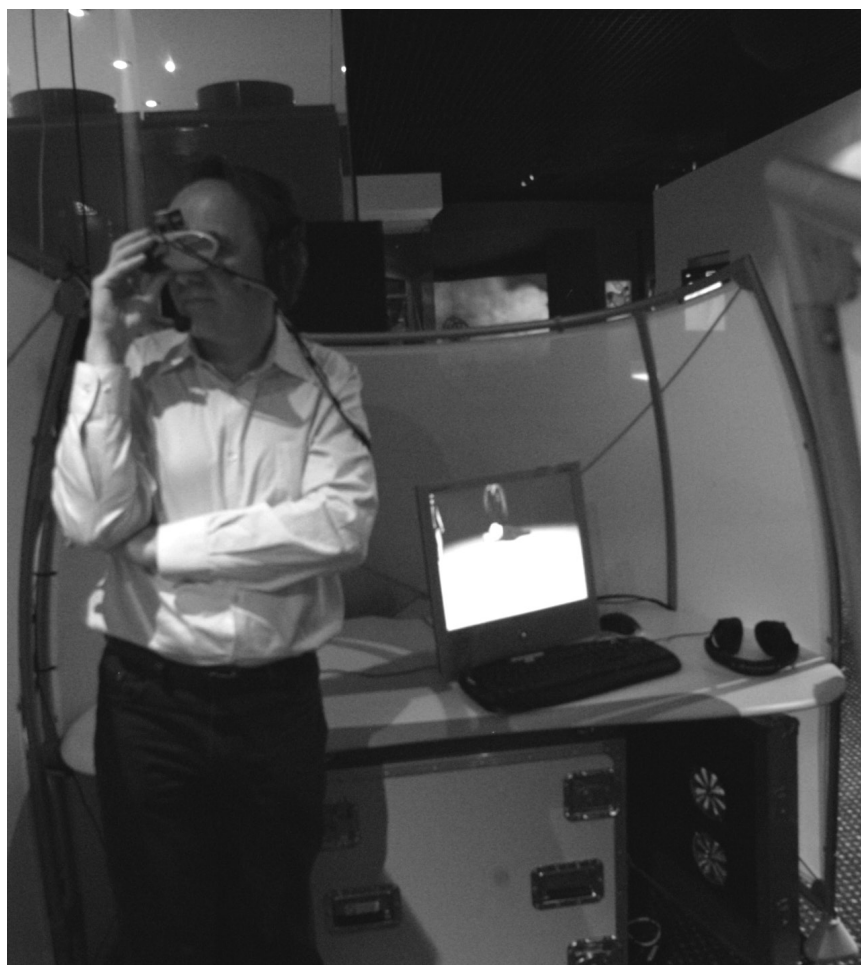
THREE INTERACTIVE NARRATIVE MODALITIES

Based on findings from previous research undertaken at iCinema, we have formulated three interactive narrative modalities, exploring these experimentally, theoretically and aesthetically. We have termed these the *polychronic*, the *transcriptive* and the *co-evolutionary*. It is the purpose of this section to set out definitions of these modalities and illustrate them with outcomes from experimental studies.

Polychronic Narrative: Re-Sequencing Narrative Events

The polychronic narrative is based on a communication between a human user and digitally generated agents, where a user can navigate her own path through pre-scripted events, able to move backwards and forwards in time at will. Usually this is through providing a shared space in which “users” and digital characters can communicate with one another, advancing a narrative through this conversation. An example of this is Dennis Del Favero, Ross Gibson, Ian Howard and Jeffrey Shaw’s *Conversations* (2004–2006) (Figs 1, 2), a work in which users at three different locations in a gallery wear virtual reality (VR) head-mounted displays. By this, and the further transposition of the users’ head movements into the movements of an avatar, the users become inhabitants of the panoramic landscape of Pentridge Prison, the site of Australia’s last public execution. The users navigate through this landscape,

Fig. 1. Dennis Del Favero, Ross Gibson, Ian Howard and Jeffrey Shaw, *Conversations*, interactive VR installation, 2004–2006. (© Dennis Del Favero)



activating levels of a narrative of the trial of Ronald Ryan, the last man hanged, and meet the central protagonists of his trial, presented as ghosts that populate the VR space. The users also see one another, as nondescript avatars that explore the scene, activating sections of history, rather than receiving it as a linear narrative.

This narrative system is termed *polychronic* following its definition by David Herman in his essay “Limits of Order: Toward a Theory of Polychronic Narration.” He states,

[Polychronic narration] is not a complete absence of sequence or the lack of definite sequence but instead a kind of narration that exploits indefiniteness to pluralize and delinearize itself, to multiply the ways in which the events being recounted can be chained together to produce “the” narrative itself [14].

Following Herman we can say that a narrative is polychronic when the sequence of events is not a stable and linear structure. Rather, because the events are multiple, the user can rearrange them and link them together in different ways. In essence, to repeat what was said above, this allows the user to *perform* the narrative through her activation of events. In polychronic narration the user can de-territorialize and pluralize the narrative, removing it from a linear conception of history told from a single perspective. *Conversations* is polychronic, as the human users explore the narrative space for themselves, activating narrative events through their reconstruction of the scene. The sequence of events does not exist as a linear structure already established by an artist but rather as digital information, which is put into sequence through the performative actions of a user.

Transcriptive Narrative: Re-Assembling Data

A transcriptive narrative is so termed because it involves the assembly of previously unrelated events into a narrative structure. Transcription here can be taken as similar in meaning to a translation or transcoding from one form to another. An example of transcription can be perhaps best seen in musical transcription, where a previously un-notated melody is written down, where a score is re-written for another instrument, or the actual musical notation is played higher or lower, transcribing the score into a different key. In terms of an interactive narrative system, this refers to a user exercising her agency by reorganizing information from the machine’s da-



Fig. 2. Dennis Del Favero, Ross Gibson, Ian Howard and Jeffrey Shaw, *Conversations*, interactive VR installation, 2004–2006. (© Dennis Del Favero)



Fig. 3. Advanced visualization and interaction environment. (© Dennis Del Favero)

tabase, taking it from the organizational and relational structure of the database and transcribing it into a new narrative structure [15]. An example of this is Dennis Del Favero, Jeffrey Shaw, Neil C.M. Brown, Peter Weibel and Matt McGinity’s *T_Visionarium* (2003–2008) (Article Frontispiece and Color Plate A), an immersive and interactive work that, via a 360-degree projection system named the Advanced Visualization and Interaction Environment (AVIE) (Fig. 3), surrounds the participants with a multitude of stereoscopic video clips taken from

Australian television. Using a handheld interface, the user can reassemble these clips by selecting any one particular moving image. Based on a content recognition algorithm and a database search engine that looks for visual similarities, emotional similarities and other non-semantic cues, the clips can be assembled based on their individual properties and those that the system has been set up to search for. Here the narrative is transcriptive in the sense that the user enacts her agency by reassembling the video clips, which once existed as diverse linear nar-

ratives on television screens, into new combinations. In this sense, the user is given the agency to transcribe the multifarious information of the work's database—to transcribe the chaotic overload of media information—into a narrative, albeit one that is told from multiple and ever-shifting perspectives. The work is also transcriptive from the perspective of the agency of the artist and the agency of the computer programmer. Both the artist and the computer programmer de-contextualize the televisual information from its usual setting on Australian free-to-air television and transcribe it into the different milieu of the organizational context of the database. What once existed as one event within a larger linear sequence of events now exists as one event amongst many others in the database's non-linear architecture.

The difference between the transcriptive narrative described here and the previously described polychronic narrative is that in the polychronic the user is involved in a re-sequencing of narrative events as they populate a shared narrative space. In a transcriptive model a user re-organizes complex, multi-modal data editorially, drawing together a nar-

rative as a series of choices affected by experiences emerging from exposure to the density of the information. The difference here is that in the polychronic the events of the story are past and are retold as the user activates different sections from the sequence of a narrative, outside of their original temporal order. In a transcriptive model, the narrative has yet to be told. The user *constructs*—or perhaps better termed *performs*—the narrative as they impute meaning arising from the consequences of their experience of aesthetically rich multi-modal information and call upon their reaction in deciding what to do next. In the polychronic the basis for narrative choices is constrained within the options provided, while in the transcriptive the narrative is poised for reassignment by the user.

The transcriptive reassignment of complex multi-modal information, however, is only practical within the dialogic context of immersive environments. Only within the technical possibilities afforded by digital technology can the beholder, retaining the role of beholder, assert autonomy over the temporal direction of the narrative by reference to the impact of the information upon her experi-

ence. The analysis of televisual kinds of information in the manner of a pleated and creasing topology of experience produces narrative as an episodic unfolding of events. The recombinatory software and its associated interfaces furnish the beholder with multiple entry and exit points to the information and with the facility to rehearse it as narrative content on the fly. Thus the software interfaces in which the algorithms are deployed are engineered to capture existing televisual information in ways that are sufficiently sensitive to the nuances of its eventfulness for the beholder.

The imputational reasoning that guides the design and application of the transcriptive software mirrors the social realism of John Searle [16]. Searle argues that meanings are ascribed to cultural artifacts according to the functions their stakeholders agree upon for them to perform. He cites money and calendrical time as instances of significant social artifacts existing only by virtue of the functions attributed to them. Insofar as functional properties can be ascribed, it follows that properties, such as international rates of currency exchange or the aesthetics of media information, are

Fig. 4. Dennis Del Favero, Jeffrey Shaw, Steve Benford, Johannes Goebel, Maurice Pagnucco and Stephen Sewell, *Scenario*, interactive and immersive installation, 2010. (© Dennis Del Favero)





Fig. 5. Dennis Del Favero, Jeffrey Shaw, Steve Benford, Johannes Goebel, Maurice Pagnucco and Stephen Sewell, *Scenario*, interactive and immersive installation, 2010. (© Dennis Del Favero)

always open to re-ascription as they are put into flux through the interaction of players or the intersection of mediating agents. However, susceptibility to re-ascription does not necessarily render functional attributions as relativistic, fickle or self-serving if, argues Searle, ascriptions are authentically motivated by institutions of craft, knowledge, education and ideology [17]. Neither does the process of ascription herald a descent into rational determinism or, conversely, trivialized chaos. As Pierre Bourdieu points out, the ascription of felt changes in artistic function, for instance, although generated intuitively, may be attributed for very good emotional and aesthetic reasons [18].

Co-Evolutionary Narrative: Narrative as a Shared Autonomy

A co-evolutionary narrative is so termed because the narrative *evolves* or *emerges* based on a relationship formed between a human user and a digital agent able to respond autonomously. These types of narrative, because of their reliance on unscripted outcomes, rely on artificial intelligence (AI) and machine learning research. One example of a co-evolutionary system is Dennis Del Favero, Jeffrey Shaw, Steve Benford and Johannes Goebel's ongoing research project *Scenario* (2005–2010) (Figs 4, 5). In this work digital characters populate the 360° projection space of AVIE, described previously. As users enter this space, their movement is sensed by a motion tracking system, which enables them to interact with the virtual characters, who respond to their

movements autonomously. Based upon Samuel Beckett's experimental television and theater work *Quadrat 1+2*, in *Scenario* autonomous digital agents approach the viewer for assistance in unfolding a narrative, prompt her for a response and then respond in complex and intelligent unscripted behaviors. Both the user-agent and the machine-agent are responsible for the generation of the narrative, with user-initiated processes and machine-initiated processes—as they sense, interpret and respond to the user-initiated processes—constructing the narrative on the fly, *evolving* the narrative through a common operation.

A FRAMEWORK FOR THE FUTURE DEVELOPMENT OF A RELATIONAL THEORY OF INTERACTIVE NARRATIVE

In order to build a theory of interactive narrative organized by the linkages formed between the three modalities set out above, we require a concept design focused on charting the causal linkages between these modalities and a theoretical investigation that, following Searle, involves sampling the input from a set of key stakeholders [19]. Our goal is to determine the agency of the modalities from the bottom up, emphasizing the way that they work together in the formation of an interactive narrative.

Although the three key functions presented above are set out as separate conditions for the formation of an interactive narrative, they may possess common contributing agencies. Polychronic

narrative, for instance, may have aspects that could be understood as co-evolutionary, or vice versa. Here it is not the separate operation of the functions that is important but rather the way they relate to provide a particular condition for the emergence of a system. Having been secured by previous research, the three functions of interactive narrative are ready to be assembled into a net of relational patterns so that we can explore the causal links between them.

We have evidence gathered through the previous practice-led research described above that grounds the characteristics of the polychronic, the transcriptive and the co-evolutionary as stable modalities of interaction. A relational theory would map a theory of interactive narrative formation using responses from key stakeholders to hypothetical questions based on the causal relationships between these modalities. The methodology used in the development of a theory of interactive narrative formation is appropriately framed as a comparative net of concepts held by major stakeholders pertaining to its design and reception. Setting the three modalities in functional relations enables the positing of causal connections between the polychronic, the transcriptive and the co-evolutionary with the corresponding promise of explanations able to account for the impact of one upon the other. Such a relational approach is advantageous, as it retains sufficient “neutrality” to represent variations in the results of functional relations across a wide range of interactive systems, contexts and artist/user levels of conceptual understanding. The relational design is also open to the future introduction of new functions resulting from dramatic technical and cultural change, without the need for catastrophic revision.

Relational theory, with its insistence that an object is only meaningful in relation to other objects, is particularly appropriate for questions of interactive aesthetics for two main reasons. First, narrative formation in interactive aesthetics includes the contributions made by theoretical agents to unfolding events. This contrasts with traditional narrative agency, for example as found in cinema. Traditional agency is planned into the script and post-production process [20] and its impact can be thoroughly brought to light only through the retrospective application of critical interpretation. Second, because of the theoretical shift in agency from passive to active in interactive narrative, the production of narrative meaning demands “empirical”

investigation. By “empirical” we refer to the necessity of studying evidence pertaining to the observed differences between users’, artists’ and engineers’ conceptualizations of the “causal” nature of narrative formation [21].

DESIGN AND METHODOLOGY

Because the aesthetic explanation of narrative meaning is by necessity qualified by the cognitive and experiential understanding of designers and users, the methodology used in the theoretical development of interactive narrative entails reference to human as well as empirical and critical research. Identifying the functional status of the three functions can be undertaken with respect to their causal, spatial and ontological properties under which different effects between agents can be composed. For example, the relation of a co-evolutionary narrative to a transcriptive narrative can be framed as a set of hypothetical questions designed to test the effect of one function upon the other. From this relation a question concerning the agentive effect of one function upon the other can be composed. For instance, in testing the co-evolutionary to transcriptive relation one might ask, “Can a digital agent act as a user or artist, transcribing information into a narrative?” In testing a transcriptive to co-evolutionary relation one might ask, “Can an artist or user transcribe the actions of a digital agent into a narrative?” These examples pose quite different terms in the relations between formative agents and will include modeling among three-way linkages, when, for example, a co-evolutionary modality relates to a polychronic and to a transcriptive modality.

Not all relations between the polychronic, the transcriptive and the co-evolutionary will be productive. Some linkages will be trivial, some too dense and some only applicable to specialized domains. The aim is to develop a suite of questions expressed in a form accessible to vernacular users but able to receive answers at a level corresponding to the conceptual understanding of the respondent and suitable for interrogating works and literature pertaining to interactive narrative formation.

MAPPING INTERACTIVE NARRATIVE FORMATION: FUTURE RESEARCH

The interdisciplinary origins of interactive technology currently receive significant inputs from domains of media art,

new media theory and computer science as well as social theory and patterns of popular usage. Interactive narrative is thus a product of these contributing domains and as such their conceptual points of view demand representation in a relational theory of interactive narrative formations.

Our approach will entail the sampling of concepts held by significant artists working in new media, computer scientists with a demonstrated contribution to interactive narrative technology, “vernacular” users of interactive systems including regular users of computer games, net- and entertainment-based systems, and social networking. Responses are drawn directly through interview and indirectly through the interrogation of works, literature and technical properties of hardware and software pertaining to interactive narrative formation. Each respondent will be interrogated by the same set of relational questions as developed under the concept design. Each question will be framed to require two responses: a low-inference response for comparative purposes, such as “yes” or “no,” and a high-inference, open-ended elaboration extended by prompts where needed.

The interview responses and interpretive surveys will then be analyzed and compared, in anticipation of a general snapshot emerging as a web of comparative relations between each group. It must be remembered that a theory of interactive narrative formation, although causal and explanatory, is nevertheless framed within the philosophy of aesthetics. Thus care needs to be taken not to impose a false level of precision from the results, to distil a deterministic explanation or to dismiss responses that express inconsistent reasoning.

This paper has set up a framework for an investigation of a relational theory of interactive narrative, understanding these systems as a dynamic relationship between multiple agents. Narrative, communication and technology are inextricable from one another, each contributing to the way we understand the contemporary world and the relationships that we form within its digitally mediated condition. As such, a relational theory of interactive narrative is central to grappling with questions associated with aesthetics and communication in the digital era. The answers postulated in the process of mapping such a theory provide the basis for empirical testing and thus further securing of the theory. This paper has identified three key functions responsible for interactive narra-

tive in new media, as tested in previous iCinema research, and set the foundations for future research to develop a relational theory that charts the agency of these functions into a relational map of narrative formation. Future research would then be able to tease out the patterns of narrative formation through the analysis of the explanations provided by the key stakeholders in the design and use of interactive systems, moving us closer to understanding the experience of the digital encounter and the affect of interactive aesthetics.

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Glossary

agency—the capacity to act in the world and to act on other agents. An agent may be human or non-human, actual or virtual, real or fictitious. Possessing agency does not necessitate possessing the capacity to reflect upon actions or cognitively deliberate over actions.

interactive narrative—the way meaning is ascribed to the processual series of events that arise from the active engagement of a human being with technological systems.

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Merrill Lynch Foundation
Emanuel Nadler
Nessim & Associates
Sam Okoshken
Steve Oscherwitz
Trudy Reagan
David Rosenboom
Jack Sarfatti
Joel Silverman
Christian Simm
Meredith Tromble

Flying Machine

(\$250 to \$499)

Loren Basch
Marc Böhlen
Ray Bradbury
Bettina Brendel
Shawn Brixey
David Carrier
Eva Craig
Holly Crawford
Eugene Epstein
Lawrence Fane
Herbert Franke
Doreen Gatland
Pamela Grant-Ryan
Oliver Grau
Linda Dalrymple Henderson
Robert Hill
Curtis Karnow
Melinda Klayman
Kathleen Laziza
Thomas Mercer
Gianluca Mura
Frieder Nake
Barbara Nessim
Jack Ox
Ed Payne and Liss Fain
Nancy Perloff
Frank Popper

Harry Rand
Beverly Reiser
Mark Resch
Eric Roll
Edward Shanken
Leonard Shlain
Jesse Tischler
Joan Truckenbrod
Kelvin Tsao
Annette Weintraub
Jonathan Willard
Barbara Lee Williams
Richard A. Wilson
Stephen Wilson
Gary Zellerbach

Angel

(\$249 and under)

Anonymous, Aaron Alpar, Charles Ames,
Craig Anderson, Art Science Collaborations Inc.
(ASCI), Yasuhiro Asoo, Bret Battey, Marc
Battier, Mark and Lauren Beam, Patricia
Bentson, Timothy Binkley, The Birse Family,
Deborah Branton, Robert A. Brown, Ronald
Brown, Willi Bruns, Annick Bureaud, James
Burke, David Carter, Rosa Casarez-Levison,
Webster Cash, Katherine Casida, Joel Chadabe,
Alison Chaiken, John Chowning, Richard Clar,
Computer Art Studio/Gunter Schulz, Anna
Couey, Rachel Crawford, Ivo Cristante, Elizabeth
Crumley, Mary & Michael Cunningham, Danish
Film Festival, Bob Davis, Derrick de Kerckhove,
Goery Delacote, Lily Diaz, Agnes Denes, Emma
Lou Diemer, Steve Dietz, Augus Dorbie, Hubert
Duprat, Elmer Duncan, Ann Elias, Sherban
Epure, Theodosia Ferguson, John Fobes, Tim
Fox, Alan & Mickey Friedman, Ryoza Fujii,
Kai-hung Fung, David Gamper, Jonathan &
Donna R. Gennick, George Gessert, Ken
Goldberg, Yusef Grillo, Karen Guzak, Craig
Harris, Isabel Hayden, Margaret Hermann,
Doris Herrick, Estate of Dick Higgins, Anthony
Hill, Toshiyuki Hiruma, Gerald Holton,
Hungarian University of Crafts & Design, Amy
Ione, Susan Joyce, Raymond Jurgens, Eduardo
Kac, Robert Kadesch, Marshall Kaplan, Ken
Knowlton, Zdenek Kocib, Kenji Kohiyama,
Thomas Kostusiak, Kathleen Laziza, Levi
Family Foundation, Frederick Loomis, Carl
Machover, James Maher, William Marchant,
Delle Maxwell, Elliot Mazer, Kevin Meehan,
Minneapolis College of Art & Design, Mit
Mitropoulos, Moët Hennessy-Louis Vuitton,
Jason Monberg, Roger Mulkey, Geetha
Narayanan, Alex Nicoloff, Greg Niemeyer,
Hiroshi Ninomiya, Elaine Petschek, Anne
Brooks Pfister, Glenn R. Phillips, Victor A.
Pickett, Otto Piene, Ann Pizzorusso, Herbert
& Joan Webster Price, Patric Prince, Wolf
Rainer, Peter Richards, Ron Rocco, Peter
Rudolfi, David M. Russell, Mr. and Mrs. Robert
Russett, Colin Sanderson, Piero Scaruffi,
Patricia Search, Allan Shields, Gregory C.
Shubin, Joel Slayton, John Slorp, Avril Sokolov,
Kirill Sokolov, Christa Sommerer, Rejane Spitz,
Anait Stephens, Robert Strizich, The Sun
Microsystems Foundation, Inc., Marcia Tanner,
Robin and Barbara Tchartoff, Tamiko Thiel,
Rodrigo B. Toledo, Heinz Trauboth, Mark Tribe,
Karen Tsao, Roman Verostko, Alexandre
Vitkine, Natalie & Mark Whitson, Alan
Thompson & Sharon A. Widmayer, Ioannis
Yessios, Robert Zimmerman