

Configuring Hospitable Space¹

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Configurable Space

This is a retrospective describing a research project based on simulations of future artists' work environments. The *Configurable Space* project explores the creative process, and examines the tools and processes that form the foundation for technological resources designed to support creative activities. It is directed towards the development of a balanced understanding about how we use the visual, aural, tactile and configurable capabilities of digital technologies, and how the tools developed affect ways that we think, feel, formulate, and develop on intellectual, spiritual and emotional planes.

Configurable Space environments incorporate any available technology that could be used to support the illusion that the implied resources already exist. The simulations incorporate representations of interactive computer display tables, walls and holographic images, within a multi-dimensional sound environment. This creates the context for exploring relevant issues and for imagining how the space might be used in actual circumstances. This retrospective describes the various manifestations of the project, spanning a five-year period.

The design methodology is based on the creation of models that simulate the functioning and potential usage of hypothetical systems. This method allows for modeling without the limitations imposed by considerations for specific implementation details, and carries the significance of being able to address ideal states. The goal is to provide paradigms to guide long term development, a goal that is particularly essential in considering virtual reality or immersive simulation technologies, given the fact that the computer resources available today are so constrained relative to the hypothetical systems they are designed to emulate. Liberation from implementation considerations paves the way towards a clarity in conceptual design. Issues relating to the use or non-use of head or hand gear, or even physical versus virtual input/output devices, becomes a question of personal preference and contextual requisites, rather than a technological necessity.

The following descriptions outline the evolution of the project and the basic concepts which form the foundation for the research.

Configurable Space I: the original installation

The set for the original installation consisted of a light table, a light wall, slide projectors, a chair, a piano bench, and a table with a water jug and candles. The materials were installed in the corner of a large studio space. The design of the space, including the size and positioning of objects in the environment, was created to reinforce an impression of a totally immersive experience. The additional room props support the impression of the environment as a complete room view, surpassing the limitations of physical display devices.

San Francisco-based photographer Marion Gray took over five hundred photographs during multiple sessions working in the environment, using sketches on transparencies, colored gels, slide projections, and live drawing. These images capture various perspectives of room views and close images, documenting the sketching and representation process, the evolving environmental characteristics and the resource requirements during the evolution of a music

composition. The original installation was constructed primarily for the purpose of creating the initial collection of slides and photographs, and not as a public art installation. The creative context emulates a non-real time studio shooting process, resembling a procedure which one would go through to create a series of animated sequences of visual material.

The envisioned technology supports the following resources and ideals:

- Large integrated and interactive display tables and walls; dynamically sizable interactive projected images.
- Multidimensional and multi-channel sound capability, with simultaneous record and playback facilities, and real-time digital mixing and processing.
- Comprehensive and integrated resources supporting transparent, translucent, reflective and opaque overlay and mixture of visual elements on any surface.
- Touch- and sound-sensitive surfaces, space and control devices, incorporating any images and sounds, or any combinations of images and sounds imaginable. Size, shape, sound, spatial characteristics, and styles of interaction are all elements that coincide directly with creative intent and personal style.
- Dynamic configuration of all resources with any kind of visual and audio templates for creating and performing in the environment.
- Direct control of the total environment, following the natural flow of an individual's creative energy. This is in contrast to resources that force one to work with resources that contain preconceived notions about what art is, or how the human process is supposed to work.
- Elaborate history tracking, analysis and presentation resources.

Sound and Image As ...

Sound as music

 Sound as environment

 Sound as signification

 Sound as articulation

Image as art

 Image as environment

 Image as signification

 Image as articulation

This is a poetic expression that characterizes the underlying concepts of *Configurable Space*, addressing global concepts that govern the senses of sound and sight. These categories orient the audience in fundamental concepts that guide development and communication. In this section I will briefly define each category, as they apply to the foundation for *Configurable Space*.

In order to develop effective and comprehensive resources that are intended to support human activity, one needs to address the various ways that we create, assimilate, and interact with sonic and visual material in an intricate and constantly evolving environment. It is essential to devote attention to, and to develop an appreciation for the fine detail of direct local interaction, and for the global perspective for environmental control. In the realm of direct interaction, communication and expression, one may turn something on or off, as in the beginning or ending of computer applications; one may initiate control commands for processing, as in editing within applications, or one may move items around to assign structure within the space. Indirect interaction, communication and expression would include creating parameters that control global environmental characteristics and processes, such as creating global environmental characteristics that affect ambiance, perception and orientation within the space, or an area within the space; configuring generalized space utilization principles governing attention, notification, history tracking, geography, and concept recognition and representation.

The sound and image realm discussed and portrayed embodies the *Configurable Space* concepts, and contains the basis for examining the character of the environment and its technological requisites. As is the case with any artistic expression, these sounds and images reflect communication on many levels. There are many interpretations which address issues of representation, interaction, performance, and communication to self and to others. Every listening and reading carries new significance, reveals new insights, affects perception of consequent hearings and viewing, and can be explored for its detail and for its overall character. It is further affected by the attention and intent brought to the activity, and by the orientation and personal history of the perceiver. The success of this endeavor depends on the ability for the sound descriptions, the images and the discussions to call upon the reader's and viewer's unique experiences and perspectives, and to excite their imagination to explore how the concepts relate to their individual domains.

Sound as music

Music can be played as a form of entertainment, carrying additional requirements for the nature of the attention and perspective that the perceiver brings to the situation. Concert music, whether performed in a concert hall or on an electronic playback system can fall in this realm. The musical and aesthetic perceptual mode may be reinforced by other elements when music accompanies or interacts with the visual domain, such as in an operatic context or in a ritual dance.

Sound as environment

Sounds and even music can be used for the ambient qualities, as a backdrop that reinforces the specific content or context within the environment. White noise or low volume music may be used to drown out other sounds in the aural space, or may further be used to intentionally create a mood conducive to orientation within one's work. One may maintain sonic palettes for orientation among multiple simultaneous threads, with discrete, controllable and configurable driving forces that transform dynamically as one maneuvers and works in the environment.

Sound as signification

In this domain a sound embodies a specific meaning. The sound of a streetcar going by or a dog barking carries different significance than the ringing of a telephone or a sonic indication that a process needs attention. These examples are different from a sound that relates to an element within a music composition, or a sonic representation of a scientific principle. In this category sounds carry significance, or meaning.

Sound as articulation

This category refers to sonically defined structure. Sound is used to articulate moments, such as might define a rhythmic pulse, the completion of a musical phrase or an entrance into a new local or global environment.

Image as art

This domain includes pictures, photographs, moving images, or any visual content presented in a context that is oriented towards the presentation of art. The context orients the perceiver in an aesthetic mode, requiring a specific kind of attention and participation.

Image as environment

Wall paper, even if it is animated and configurable, affects the character of the environment. In the same way, the furniture, ambient lighting, and directed spot lights all contribute to the character of the environment and the focus brought to its contents.

Image as signification

This domain includes textual meaning, such as text that is language, and iconic representation, such as graphic elements that reduce or define objects and concepts. In the case of an image of a piano keyboard, for example, the representation carries a meaning relating to a physical

object, a sound realm, a method of interaction, and a nearly 300-year historical reference spanning multiple cultures and musical styles.

Image as articulation

Visual characteristics can be used to frame concepts, to articulate events within the space, and to define connections among collections of things along with defining the nature of their connections. Lighting may change in order to view an art video, articulating a change that serves a transformation that alters one's attitudes regarding that which is about to occur. This consequently affects the experience and the perceptual modes one uses to interact in the specific circumstance. These concepts are operative within a single image, a collection of images, the environment as a whole, a revised perspective of the environment, or an entirely new environment.

Topical Orientation

In order to delve deeply into the character and requirements of the imagined creative environment, fundamental issues are categorized into a collection of topics, and I explore the technological resources required to support activities in that category. The topical orientation consists of a series of scenarios composed of image and sound that form the basis for exploring the meaning of these captured moments. The content examines the origin and evolution of ideas, their representation and connections, and the nature of the technological resources required to explore, develop and express ideas completely. The depth spans a range from early sketching stages through to completely refined representations. Activity in any or all of the categories can exist at any time, in any relative weighting, affecting the balance on surface and deep structural levels. I endeavor to expand beyond the realm of specific task-oriented tool development, developing a perspective that incorporates the entire being and the total environment.

Idea and Representation

Idea and Representation addresses the arrival and character of ideas, and mechanisms for their representation during early stages of the sketching process. Resources at this stage maneuver in a delicate balance between requirements of speed, clarity, and flexibility. No assumptions are made about style, representation techniques, or even the character of the end product. In this realm the resources must respond to rapid sketching or prototyping requisites, and must be sensitive to broadly defined symbolic reference with respect to textual, graphic, sonic, and gestural activity. The refined line and specification of fine detail are superseded by the need to express concepts and relationships.

Elaboration by degree

Ideas progress at different rates from their raw forms to more refined and detailed stages as the sketching process continues. The tools needed at this stage must reconcile disparities between different styles of representation and varying degrees of specificity. Salient surface detail and structural features need to be carried through to each sketch or version of the work, with facile capabilities for viewing, developing and integrating sets of related sketches. Requirements in this arena include tools for representation and generation that span a vast range from the primitive to the refined, allowing the artist to work to the degree of specificity and at the rate of activity required by the context.

Levels of Detail and Structure

As music exists in time, so do the processes that create it. These processes are not purely linear. Multiple layers of activity operate simultaneously, ranging from local levels of detail to larger architectural design. Work in the environment operates on many layers of activity and levels of perception. Flexible and natural movement among concepts, versions and layers, maintaining clear connections among all elements, are characteristic of this category, whether the reference is to a specific work, or to the environment as a whole. Resources serve the artist's internal sense for spontaneity and continuity.

Different Views of the same thing

Several manifestations of an object are imaginable; several paths to follow in developing a concept can be envisioned. The orientation of the user and the specific context or function being performed affects the nature of the representation. Representation and resource requisites differ for such contexts as conducting, performance, theoretical analysis, musicological research, structural design and sound design, though all of these activities share a common set of related concepts and processes. In *Configurable Space* these become different views that combine to assist in refining concepts, and to enhance perception and communication. The ability to design multiple views and to maneuver among levels of detail and architecture within one's work places the participant beyond the surface of things into the realm of abstraction, enhancing the perception of simultaneous and contiguous threads of the same and different things.

Connections among Room Views

Decisions relating to potential paths or directions for exploration are connected directly with knowledge, experience and understanding about past and present circumstances. The recollection of history as well as the flexibility in its presentation enhances one's ability to understand the myriad of paths to and from a point, a concept or a moment. A configurable, "environmental" audit trail maintains a connection with the total work and the complete environment, including the character and qualities that were part of the developmental process.

Configurable Space Installations and Performance-Presentations

Each expression of *Configurable Space* incorporates material prepared for and created during prior manifestations, addresses the same essential issues as they evolve, and includes new issues as they surface. The following descriptions of selected manifestations of *Configurable Space* clarify and illustrate the design and nature of this evolving project.

Configurable Space II: hard copy publication

Sixty-five images from the original 1989 installation were integrated with a poetic textual storyboard based on the topical orientation described above. This was formed into a chapter for publication in the *Companion to Contemporary Musical Thought*, published by Routledge in 1992.² Each topic had a dedicated section of the chapter, with a design and layout that visually supported maneuvering through the information. Both text and images followed the storyboard, with the intention that the images could be read and assimilated independently, as well as in conjunction with the text. The images and text were indirectly referential, with no explicit mention of any images in the text, though the connections between their respective content were revealed in careful exploration.

Configurable Space III: synchronized multimedia performance-presentation

In the fall of 1989 I presented the first two public *Configurable Space* performance-presentations, as a special presentation at the 1989 International Computer Music Conference at Ohio State University, and as a guest composer at the University of Texas Arlington. The presentation technology consisted of three slide projectors, a synchronized, multi-channel audio track, and a microphone used for live commentary. A tone track on the audio tape controlled the slide carousel movement and light intensity for each slide projector.

The goals of these performance-presentations were to communicate the fundamental concepts of *Configurable Space* to musicians and music students using computers in music applications, and to digital audio and music software developers; to experiment with alternative modes of communication of ideas using both direct and indirect methods of communication; to examine aspects of focus, environmental impact, and perception on multiple planes.

In the visual domain each of three, different-sized image projection spaces overlaps partially with the other projection spaces, and each retains part of the visual plane as its exclusive domain. The projection of larger- or smaller-than-actual size images reinforces active participation on the part of the audience, inviting them to step outside the expectations of life

and traditional modes of communication, and to experience the environment in a way that affects existence on non-linear planes. By manipulating the image placement and light intensity of each slide projector I transform the audience's perception of the room size, its shape and contents, and the focus, depth perception and visual orientation within the total space.

The sound track consisted of *found* sounds of the world, live and manipulated instrumental sounds from a composition in progress, representations of sounds from the inner ear and internal world, and control/response command communication between the artist and the environment. Each sound was processed using predominantly non-real time software systems for simulating room size and spatial trajectories, and then digitally mixed using software processes for filtering sounds, and for layering in multi-channel sound complexes. The sound track created rooms, and the layers supported the perception of rooms within rooms, with dynamic shifting among the imaginary environments. Live commentary provided declamatory, poetic and structural orientation throughout the one-and-a-half hour performance-presentation. Additional details regarding the structure of the music segments that comprised the sound track and the character of the sound realm can be found in the Proceedings of the International Computer Music Conference 1991.³ Excerpts from *inDelicate Balance*, the composition that evolved out of this process, are available on compact disc through *Leonardo Music Journal*⁴ and from Diffusion i MÉDIA⁵.

Configurable Space IV: videotaped and studio-edited documentation

In 1990 a creative residency at the Banff Centre for the Arts provided another opportunity to work with the same slide projection configuration as used in the synchronized multimedia performance-presentation described above, to further develop the sonic elements, and to experiment with video as a medium for clarifying, reviewing and documenting various aspects of the project.

New sound segments, new sketches and diagrams, and additional storyboard material were created and incorporated into the original material. The structure of the project allowed for concentrated time devoted to programming the slide projection control. The automated slide performance was recorded on videotape, and a fluid audio/video master was created in the editing suite.

In addition to previously stated goals, this manifestation of *Configurable Space* included the following goals and research interests: . . .

- Develop the concept of perception and communication on multiple planes by enhancing resources supporting transparency, translucency, reflectivity and opacity.
- Develop the sound and music concepts to clearly convey the impressions of the space on indirect levels of communication, and to clearly demonstrate the evolution of the composition and environment.
- Probe into the implications of spatial representation to convey both detail and structure in musical and extra-musical contexts.

Configurable Space VII: live, multi-person performance-presentation

Configurable Space VII was a hybrid performance-presentation sponsored by Yamaha Music Technologies in Marin, California, in May of 1990. The purpose was to demonstrate the underlying concepts of *Configurable Space* in a context permitting experimentation with multimedia communication resources. The event space, appropriately located in an office presentation space intended for corporate communication, was built around a large, white wall. Three slide projectors were positioned carefully with respect to image size, angle, and proximity, following the same design as in the earlier manifestations. A video projection system was used to incorporate the Banff video into the design and content for the performance. The multi-layered sound environment included original music, prerecorded music from different cultures and styles, and prepared soundfiles of sampled and processed sound, all placed in a variety of simulated room environments. Sound from each of two microphones was processed to create a different ambiance, reinforcing different styles of communication. I

used one, the evocation of a large room with a distant dreamy character, for story-telling and indirect communication and the other, which evoked a smaller, less-reverberant environment, for declamatory and direct communication techniques.

The work consisted of two movements. Each movement was weighted differently with respect to direct, linear presentation techniques, and indirect, non-linear modes of communication. Each movement consisted of a different balance between specific, timed accompaniment, quasi-random selection from sets of elements, and extemporaneous selection from a wide variety of sonic and visual material.

Score directions utilizing a 3-dimensional score notation were provided for live presentation assistants to perform the visual and aural components. During the event, I wrote and drew over the surface of the wall, selecting multicolored marking pens of different thicknesses, with attention towards the functional use of color, shapes and multi-dimensional containers. Writing and drawing on the wall reinforced main points, summarized internal sections within the presentation, followed tangential thoughts, and drew links between graphic and textual material written and projected. The performer of the visual component controlled slide carousel position and light intensity for three slide projectors, and also controlled the video projector. The performer of the audio component incorporated twenty channels of sound, including pre-recorded tapes and CDs, live performed sounds from the computer, live-processing of sound, two microphones, and an antique Victrola. Performers responded to what was seen, heard, and felt. Images changed and modulated in light intensities, blending, highlighting, and contrasting with the drawing on the wall.

Configurable Space VII was directed towards advancing the following goals and research interests:

- Experiment with aspects of presentation and performance that were predefined and non-changeable in previous manifestations, and work with of live configuration of materials.
- Examine technological resources which would be required to support the live event in a more interactive, multimedia environment
- Examine expressive power and effect of live drawing onto the white board while images were projected and changing.
- Expand the live commentary/presentation aspects to make use of audio support for different types of message passing.

Configurable Space VIII: customized performance presentation

In May of 1992 I presented *Configurable Space* to an audience of artists at the Exploratorium in San Francisco, California. The title of the work prepared for this event is *Configuring Hospitable Space*, created for an evening entitled *Fantasy and Fantastic Media*. In the Exploratorium presentation I constructed a twenty-minute scripted walk-through of the *Configurable Space* concepts, their origin in early childhood experiences, and the impact on my artistic development. This included descriptions about specific *Configurable Space* manifestations, a sequence of single slides, and a customized sound track offering poetic impressions of actual room perspectives. The two-microphone model used in *Configurable Space VII* was used in this circumstance. As the text moved between dreamy story telling and declamatory descriptive speech, the sound processing shifted between simulating a dreamy, distant character and a dry presentation room character, respectively. Subtle sonic punctuation on the sound track accompanied the text, articulating the grammatical and conceptual structure.

Observations

Total Environment -- Total Self

Configurable Space provides resources for the individual to control the entire range of local and global activity according to natural tendencies and work habits. Concentration on predominantly intellectual functions, linear thinking and task orientation, ignoring other

sensibilities, non-linear perception and indirect communication imprints a seriously restricted focus on our activities, and consequently imposes limitations on the ultimate functionality of the resources. Developing the environment as a totality significantly enhances the level of creativity, and assists in maintaining a strong connection with all elements of human existence.

Displays and Surfaces

Large displays, touch-sensitive surfaces, and effective use of projected images offer considerable benefit in the environment. The single monitor screen, even including multiple window capabilities and many of the effective *Configurable Space* resources, does not provide the depth of perception or the freedom of movement required to simulate a truly all-encompassing environment. There is a significant difference between physical or virtual surfaces, and a fundamental connection between the selection and use of input and output devices and the internal processes used for assimilation, development and communication. The principles that govern the nature of an application originate in human perceptual orientation, and it is most effective to construct an environment around a freely moving human, rather than attempt to build the human into a fixed and restrictive physical machine.

Transparency -- Translucency -- Reflectivity -- Opacity

The visual and audio layering capabilities of immersive technology assist memory and perception on multiple cognitive planes, creating an environment that projects aspects of the inner self onto the physical world surrounding the participant. *Configurable Space* visual resources suggest thorough and comprehensive transparent, translucent, reflective and opaque functionality, along with their sonic counterparts. These capabilities are important components in creating the multidimensional effect, and in maintaining a close connection with work as one maneuvers in a spherical environment. Touch sensitive control of the coarseness or subtlety of the mix of multiple simultaneous planes of activity, color-coding and shading of layers as a means of connection and separation, and the ability to view the entire environment from any position in the space are all factors that combine to create the sense of integration between the self and the manifestation.

Sound in the Environment

The use of sound is a critical aspect in the creation of the environment, contributing significantly to the fusing of the senses into a comprehensive, comprehensible totality, and to maintaining continuity. The use of location and sound object cues to aid in context orientation, the use of ambient characterization to identify qualities within an environment, and the configurable nature of the sound resources all contribute to the creation of a comprehensive sonic world that emulates the human cognitive and perceptual mechanism. As a resource that can provide analogs to visual concepts, it can offer unique perspectives for understanding. As a resource that becomes the primary mode of communication, sound has the expressive power to reach human sensibilities in a way that is not possible in the visual domain.

Historical Perspective

The reconstructible nature of history, and the configurability of its presentation offer a means of getting in touch with many aspects of work, even after leaving it for long periods of time. The historical perspective that a configurable, multi-track and multi-layered audit trail can provide, especially with configurable analysis and display resources, facilitates in assimilating and understanding long term projects, and in maneuvering among sets of activities on several planes. Whether the use of the historical resources is in preparing chronological sequences of room views, random sequential presentation of environments, or simultaneous imposition of multiple perspectives from different times and projects, the history and presentation mechanism is an integral component in connecting the *Configurable Space* resources with the total self.

Communication

Using the resources for communication to self and others, applying both direct and indirect modes of communication, promotes an evolution in our interactive potential. Direct, linear

communication during *Configurable Space VII and VIII* was extremely effective with the enhanced visual and aural reinforcement. Indirect modes of communication were powerful in expressing the character of the environment, providing an effective complement to the more traditional, direct techniques. The extended presentation resources facilitated dynamic and natural response to the audience, with the balance among communication modes shifting according to the specific context and orientation of the audience. The process presents a challenge to the audience to employ additional effort and concentration in processing the multimedia event as a complex formal presentation while assimilating it as a viewer of an art work.

Multidimensional notation systems

In developing the notation system for representing complex musical characteristics, it became apparent that the enhanced functionality experienced in expressing sonic behavior on multiple planes had significant implications when extended to other activities. As an integral component of the environmental design resources, multidimensional representation provides concrete visual distinction while retaining a conceptual and even time-based connection with activity on individual planes. In multimedia perception, assimilation and communication of concepts and related simultaneous threads of activity, representation on multiple planes significantly widens the bandwidth of information by providing an organization of complex data in a manner that is quickly assimilated.

Multiple person environment design

Configurable Space VII provided an important opportunity to explore the factors that a human observer/participant derives from a situation, and from familiarity with the concepts and the material presented. This helped to hypothesize about what would be required by a computer-based environmental presentation assistant. The combination of scripted or scored activity with simultaneous extemporaneous elements necessitates a collection of resources that spans a vast range from direct score-following to creative adaptation. The selection of individual sound and image components, and the careful shaping of the overall environmental character requires a sensitivity to specific content, general principles and even stylistic convention. Flexibility in real time reconfiguration of resources and content improves the ability to respond effectively to new circumstances or specific purposes, whether the situation involves artistic creation or presentation, communication, education or collaboration. The concept of an intelligent, conceptually and contextually-sensitive presentation assistant provides an intriguing model for adding additional depth to the multimedia, multi-functional, multi-person environmental design paradigm. Each participant has the opportunity to communicate using the resources which most effectively combine their natural inclinations and the current context.

Realistic Implementation

An evaluation of the *Configurable Space* project, and of long term development hypotheses in general, should examine not only the ideal state, but also should explore the model with respect to potential avenues leading towards realistic implementation of part or all of the paradigm. This evaluation process helps to assess the extent to which we need to develop a totally new technology, and the extent that current resources could be used or extended to realize the goals of this kind of environment. The knowledge and understanding resulting from this evaluation process further facilitates the development of an effective plan for implementation.

Several current projects exhibit components that can be synthesized into the integrated environment suggested in *Configurable Space*. There are active projects at Xerox PARC exploring applications of large, interactive display devices⁶; configurable, touch-sensitive surfaces; and environmental control. Don Buchla has developed a collection of touch and space sensitive control devices that could be applied to environmental control⁷. Fred Lerdahl⁸ and Stephen Pope⁹ have examined approaches to music architectural design and composition that have direct application to project management and environmental orientation. Other research

in such areas as machine control and synchronization, learning machines, intelligent agents and probes, connectionism and neural networks, multi-functional and multi-layered linking, history tracking, multi-channel spatial sound control, and collaborative environments¹⁰ all point to the potential of a comprehensive and integrated immersive environment. *Configurable Space* offers a perspective on how these resources are synthesized into a comprehensive creative environment.

¹The retrospective as it appears here is an abbreviated version of a paper being published in a forthcoming issue of the journal *Contemporary Music Review*, published by Harwood Academic Publishers.

²C. Harris, "Artistic Necessity, Context Orientation, Configurable Space", in Paynter, Howell, Orton and Seymour, ed., *Companion to Contemporary Musical Thought* (London, UK: Routledge 1992).

³C. Harris, "Found Sound - Found Structure Summary", *Proceedings of the 1991 International Computer Music Conference* (San Francisco, CA: International Computer Music Association, 1991).

⁴C. Harris, "Room Views", *Leonardo Music Journal Anthology of Music for the 21st Century*, Volume 1 (San Francisco, CA: Leonardo, the International Society for the Arts, Sciences and Technology, 1991).

⁵C. Harris, "Somewhere Between", *Électro Clips: 25 Electroacoustic Snapshots* (Montreal, Québec, Canada: Diffusion i MÉDIA, 1990).

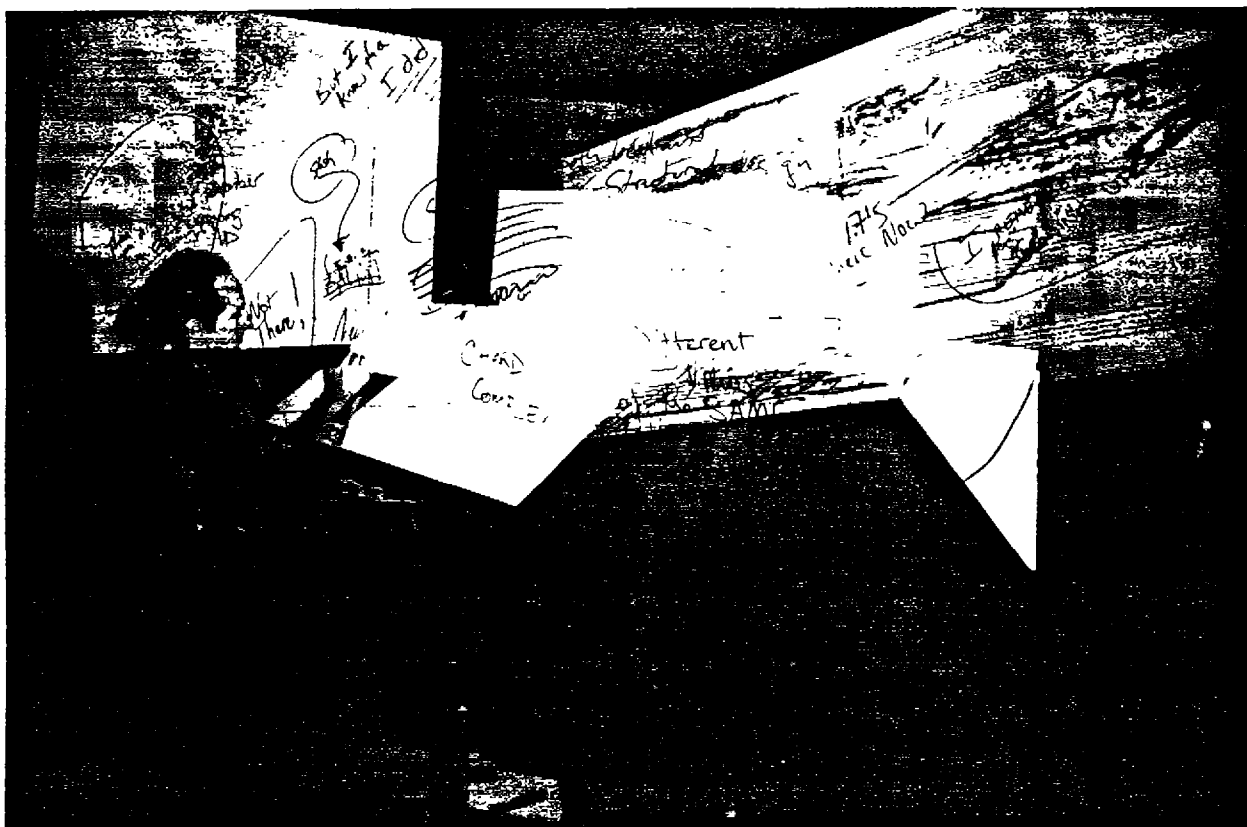
⁶S. Elrod et al, "Liveboard: A Large Interactive Display Supporting Group Meetings, Presentations and Remote Collaboration", *Proceedings of the Human Factors in Computing Systems CHI '92 Conference* (New York, NY: ACM Press, 1992).

⁷Buchla's *Thunder* device is a programmable, touch-sensitive MIDI controller; *Lightning* is a programmable, motion-sensitive MIDI wand.

⁸F. Lerdahl and X. Chabot, "A Theory of Poetry as Music and Its Exploration through a Computer Aid to Composition", *Proceedings of the 1991 International Computer Music Conference* (San Francisco, CA: International Computer Music Association, 1991); see also F. Lerdahl and Y. Potard, *A Computer Aid to Composition* (Paris, France: Rapport de l'IRCAM, 1982).

⁹S. T. Pope, "Producing *Kombination XI*: Using Modern Hardware and Software Systems for Composition", *Leonardo Music Journal*, Volume 2 (San Francisco, CA: Leonardo, the International Society for the Arts, Sciences and Technology, 1992).

¹⁰C. Codella et al, "Interactive Simulation in a Multi-Person Virtual World", *Proceedings of the Human Factors in Computing Systems CHI '92 Conference* (New York, NY: ACM Press, 1992).



Craig Harris, *Configurable SpaceVII*, performance-presentation, San Francisco, CA, 1990. The artist writes and draws on the surface of a large white wall as part of this work, which explores creative activities and communication by simulating future environments utilizing multimedia resources including sound, text and projected images.
(Photo: Marion Gray)