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SYNESTHETIC ART THROUGH 3-D PROJECTION: THE REQUIREMENTS OF A COMPUTER-BASED SUPERMEDIUM

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SUMMARY

A computer-based form of multimedia art is proposed that uses the computer to fuse aspects of painting, sculpture, dance, music, film, and other media into a one-to-one synesthesia of image and sound for spatially synchronous three-dimensional (3-D) projection. Called synesthetic art, this conversion of many varied media into an aesthetically unitary experience determines the character and requirements of the system and its software. During the start-up phase, computer stereographic systems are suitable for software development. Eventually, a new type of illusory-projective "supermedium" will be required to achieve the needed combination of large-format projection and convincing "real-life" presence, and to handle the vast amount of 3-D visual and acoustic information required. The influence of the concept on the author's research and creative work is illustrated through two examples.

INTRODUCTION

The concept of synesthetic art described here is the product of an approach to art that looks to science and technology for the invention of new media for art, and to new media as a way of expanding the aesthetic, stylistic, and expressive possibilities of art. That science and technology indeed have the capacity to play this role was demonstrated in the last century by the invention of photography and cinematography, and more recently by the invention of television. That not every application of science and technology to the visual arts has this impact, however, is demonstrated by the history of kinetic sculpture and other kinds of technologically oriented art that have appeared over the last 40 years, none of which have acquired the importance of these earlier inventions or developed into an authentic and accepted new art form (ref. 1).

In 1967, on learning that the computer, in addition to everything else it can do, is able to generate and process images, I asked myself whether this amazing brain-like technology would eventually provide the basis for a new form of art comparable in importance to photography and film. On deciding that the computer indeed has this potential, my next question concerned the character of this new form of art and the role of the computer in its production. While these ruminations took place without benefit of such terms as synesthetic art or supermedium, the concept I developed, though somewhat vague compared to my way of thinking about it now, was essentially the same as the one proposed and described here (ref. 2).

Before providing a systematic outline of synesthetic art and its requirements, it may be helpful if I briefly describe what I mean by synesthetic art and what I visualize when using the expression. The best way to do this vividly and expeditiously calls for a small exercise in "imagineering."

Think of an empty transparent block of space about the size of a 19-in. computer-graphic color monitor, its depth the same as its height. Fill this space with a collection of floating objects that vary considerably in shape and size, some small and spherical like marbles, others larger and more irregular in shape. Then add something quite different to the mix, something like a luminous cloud or foggy mist. Endow this combination of solid forms and vaporous intangibles with colors, textures, patterns, shadows, and other attractive qualities and attributes.

At this point, set the ensemble in motion, into a choreography of disappearing and reappearing, swelling and contracting, disintegrating and reassembling, changing one into another and back, and into arrays of identical objects that move choreographically to the distinctive sounds of computer music. And note that the sounds are fully as spatialized as the visual material, with many of them moving in precise spatial synchrony with them.

Though the dominant effect is more abstract than realistic, there are hints of the real world here and there. Whether abstract, realistic, or something in between, the objects pass eerily through one another, completely unhindered by visible mechanical or electrical assistance. Aspects of painting, sculpture, photography, cinema, and dance fuse into an ambience of near transparency, with objects apparently farthest from the eye nearly as visible as those that are near. With forms melting into air and air into forms, the overall effect, despite the prevailing three-dimensionality, is as pictorial–even as "painterly"–as it is sculptural. And because of the patterned and formalized movement, the affinity with choreography and the dance is as obvious as the connection with painting and sculpture.

These imaginary events in an imaginary block of space are as far from the synesthetic art of the future as they are from any method of three-dimensional (3-D) projection available today. Yet, with only minimal trouble and expense, the color monitor of an Atari 1040 ST personal computer can be converted into a not-too-crude approximation of the imaginary block through the purchase of a set of liquid crystal stereo goggles (ref. 3). The Atari is low resolution. A more expensive stereographic system with higher resolution, however, if adapted to a large-format, video projection system, could expand the block and the events within it to a scale of 6 x 8 ft or more (ref. 4). Eventually, if my confidence in the future of synesthetic art is justified, the scale of the block will be measured in yards rather than feet; the quality of "reach out and touch it" realism will be overwhelmingly convincing, and the varied happenings within the huge block of space will be correspondingly impressive (ref. 5). The computer-based method of 3-D projection that can achieve this near-perfect realism on such a scale is what is meant by the "supermedium" mentioned in the title. Though it is not impossible that this supermedium will emerge as an outgrowth of the stereoscopy and holography we know today, the limitations of both are just as likely to prove insurmountable.

In order to stress that synesthetic art is as much concerned with sound as it is with pictorial and sculptural kinetics (and eventually, with drama, performance, and narrative content as well), the block of spatial activity will henceforth be referred to as an "event space." It could just as well, however, be called a "stereo event space," in acknowledgment that 3-D projection by computer stereographics, despite its limitations, will probably incubate development of synesthetic art for many years to come.

GENERAL FEATURES OF SYNESTHETIC ART

Synesthetic art has four essential features that determine the design and operation of the computer-based system and how it is used to create synesthetic art. These features refer to (1) the comprehensive multimedia character of synesthetic art, a feature that calls on the system to either capture or simulate a wide variety of attributes and materials, both visual and acoustic, drawn from many different forms of art; (2) the bimodal spatial synesthesia of image and sound, a feature that enables the system to superimpose visual and acoustic elements and move them together in the illusory-projective event space; (3) the aesthetically integrated character of synesthetic art, a feature that calls on the system to assist in organizing these disparate materials into a close-knit synesthetic unity (an option, not a requirement imposed on users of the system); and (4) the extremely integrated and task-oriented character of the system itself, a feature that calls on the developers of the system and its software to take full advantage of the computer's ability to capture, generate, process, and spatially manipulate both images and sounds by drawing upon resources as diverse as computer graphics, image processing, computer music, and artificial intelligence, among the many germane fields and disciplines.

The block diagram in figure 1 represents all four of these features in a general way. More concretely, however, it also represents the five major blocks of software comprising the entire synesthetic package of programs, along with the quite specific requirements associated with each of these blocks. The diagram conforms to the standard format for such graphic representations, with input at the top, output at the bottom, and everything associated with the ongoing manipulation and control of the total mass of visual and acoustic information presented in the large central panel, coded in light grey.

REQUIREMENTS OF THE SYNESTHETIC SYSTEM

Some of the more specific features of synesthetic art can be gleaned from this summary of the requirements imposed on the computer system, because many of the features, functions, and requirements of the system provide mirror reflections of synesthetic art itself.

Realism

During the start-up stage of synesthetic art, a high degree of realism is hardly an achievable, or even desirable, objective. From the very beginning, however, some use of low-resolution, generalized forms of realism are necessary, first for aesthetic variety and interest, and second as steps in the direction of the narrative and dramatic realism associated with the long-term full multimedia potential of synesthetic art. As an aspect of this eventual development, the degree of near-perfect realism should be such that an observer peering casually into the event space might easily fail to distinguish between the projected image of an object and the actual object itself. This can be thought of as the ultimate "Turing test" for 3-D projection, a level of "reach-out-and-touch-it" realism that may never be fully achieved, but that is useful nonetheless as an unambiguous standard and objective for ongoing research and invention (ref. 6).

Realism in synesthetic art, in whatever degrees and varieties it appears, will be achieved through a method of real-world image capture that is basically photographic, whether involving video, cinematography, or some other method. Or it will be achieved within the computer itself through image synthesis "from scratch," using mathematical and algorithmic techniques along the lines of solids modeling and ray tracing. Or the realism will be achieved through combination of both of the preceding, or perhaps through a method yet to be developed. A key requirement would seem to be a method of 3-D capture that digitizes the information as it is acquired, facilitating its transmission into the computer and submission to the myriad form transformation operations basic to this concept of synesthetic art.

Abstraction

The second requirement shifts away from realism to the opposite end of the stylistic spectrum in demanding that the system supply an endless variety of visual qualities and attributes having as much to do with abstract art as with realism. These attributes, which are at the core of synesthetic software along with objects they enhance, pertain to such basic elements as form, shape, color, texture, pattern, tone, translucency, hard and soft edges, optical distortions, etc. Ideally, any of the styles and iconography associated with 20th century visual art and its media–starting with painting and sculpture, but also including photography, printmaking, computer graphics, computer animation, video art, abstract film, laser sculpture, and light art–should be capable of being simulated and, if necessary, translated into an effective 3-D equivalent idiom for integration into the synesthetic mix. In time as the synesthetic software package expands, synesthetic artists should be able to work in virtually any style conceivable, with no constraints other than those self-imposed for expressive or aesthetic reasons. The objects mentioned in the Introduction, and their mutations as arrays, regions, and total event spaces, are represented in the block diagram under the general heading of "visual/spatial components."

A Choreography of Change and Motion

The third requirement of the synesthetic system and its software pertains to the choreographic aspect of synesthetic art and to the ability of the system to adapt its visual elements to interesting scenarios of change and movement within the event space. This time/dynamic component is clearly choreographic in character, whether actual dancers are projected into the event space, or whether the "dancers" consist of abstract shapes, colors, textures, or wisps of smokey ephemera moving about and through one another.

This choreography has three aspects. The first is a choreography of change associated with such terms as mutation, permutation, transformation, and metamorphosis; this has a topological aspect as well. The second is a choreography of movement in space, a shift from here to there, or of continuous movements over looping and interweaving paths of motion within the event space. (See the panel labeled "object motion and motion paths" in the block diagram.) And the third imposes a choreographic aspect on the timing of the change and motion events, which can accelerate and decelerate, and involve modulated shifts of timing as complex and subtle as the graceful movement of a ballerina, whose art consists as much in the timing of a movement as in the sculptural shape and arc of the movement itself. (See the panel labeled "time/change/motion synesthetics" in the block diagram.)

Music and Sound

Just as the visual/spatial aspect of synesthetic art is able to draw upon and enlarge the entire body of resources of computer graphics, the musical/acoustic aspect is able to do the same within the closely associated fields of electronic and computer music. Important among these resources are the many customized interactive devices (keyboards, pedals, sliders, dials, the insertion and extraction of floppy disks) developed for composing and improvising computer music. Also important is the fact that sounds, like images, can be either captured from the real world by microphones, or synthesized through electronic or digital techniques (ref. 7).

Most important is the computer spatialization of sound that is so central to this concept of bimodal synesthetic art. Evidence is plentiful that the existing, well-proven technique of spatializing sounds by computer is growing in use and aesthetic effectiveness. For example, just within the past year, a spatialized composition of computer music was incorporated into a 45-ft open-form sculptural construction as a bimodal mix that is almost borderline synesthetic (ref. 8). In fact, if the sculpture itself, which is completely immobile, were kinetic in some way, and if the spatialized sounds interacted meaningfully with the kinetic aspect of the structure, the work might approach the synesthetic.

Production and Performance

The system and its software must provide its users with the means to work in a variety of modes for creating many different kinds of synesthetic art. In addition to working directly and interactively with the system, the user should be able to take advantage of intelligent robotic and quasi-robotic support when it is needed for a specific purpose–i.e., a fast-moving improvisation in which the performer(s) could not possibly keep everything in hand without intelligent robotic support from the system. This robotic-type support is not only helpful, it is absolutely indispensable when the system is sustaining an ongoing "hands-off" performance, a special way of using the system that, depending on the inclination of the user, may involve either intermittent, frequent, or constant intervention into what the system is doing. (If the intervention is constant, the user has switched by definition into the fully interactive mode.)

Within these automated productions, an important subset is the transductive mode, yet another hands-off situation that essentially replaces the artist as sole intervenor, with intermittent or ongoing interventions from a variety of sources—interventions which are continuously mediated and structured by discriminating and aesthetically "sensitive" robotic components within the software. These intervening agencies in turn are made up of ambient energies, signals, and other "information" such as light, heat, sounds, vibrations, barometric pressure, brain waves, heartbeat, traffic patterns–many of the endless possibilities have for years been incorporated into diverse forms of environmental, transductive, and "systems" art, some of them computerized, most of them not (ref. 9). Clearly, synesthetic art produced in the transductive mode will acquire many specific forms for many different kinds of users and applications, all of them so readily interchangeable that the distinction between an amateur and a professional performance will tend to blur (or will, that is, if the artist working with the synesthetic system wants it that way).

Not least important is the fully robotic mode, in which the system, driven by a program that the artist has set up (or more rarely, may even have written, or possibly expanded), behaves like an autonomous artist in its own right in producing either a continuous, ongoing work in the performance mode, or a series of individual productions in the serial-robotic mode. This fully robotic approach is not as far-fetched as it may seem; variations of it have been used for years by some of the pioneers of computer art in this country, Europe, and elsewhere (ref. 10).

TWO PROJECTS ON THE FRINGE OF SYNESTHETIC ART

Synesthetic art as a concept has yet to produce an actual example of the genre to discuss or reproduce here. Nevertheless, I have been involved with a number of projects peripheral to synesthetic art over the years. These can be used to illuminate the subject, but should not be misconstrued as examples of what is still an art of the future. From these I have selected two projects, the first as an example of software oriented strictly to the robotic mode, and the second for its combination of both interactive and robotic possibilities.

Applications of the Serial-Robotic Mode

An example of software capable of generating graphics in a serial-robotic mode is the largest and most complicated of the programs I have designed and developed to date. Called SHAPE3D, it was written during the middle 1970s with the help of two talented student programmers primarily as an experiment in the serial-robotic design of sculpture. In addition, however, the project reflects my long-standing conviction that the computer, in addition to its contribution to the creative aspect of art, also will foster a new approach to research in art theory and aesthetics. More specifically, the idea concerns a highly promising synergism of theory and practice between (1) the use of successive series of serial-robotic productions as an innovative and potentially powerful approach to computer-based research in art theory and the principles of design; and (2) the testing of the rules, principles, compositional devices, etc., generated by this research through their use in the serial-robotic production of various kinds of computer art. Of course, synesthetic art is obviously the kind of computer art with the most to gain from this valuable source of robotic intelligence concerning formal/syntactic structure-inducing algorithms and devices (refs. 11-14).

Operating with a vocabulary of 64 modular block-like elements and a set of 30 input parameters, SHAPE3D is capable of generating serial-robotic runs of as many as 50 or 100 or more graphics at a time, with never a duplicate composition in any series. The six graphics comprising the group reproduced as figure 2 were selected from a number of different serial-robotic runs to demonstrate the range of variations in style that can be obtained through various settings of the 30 parameters. The single unframed graphic in the group of six was selected from a serial-robotic run of 150 compositions, the best of which was chosen as a model for the complete sculpture shown as figure 3 (ref. 15).

Calligraphic Stereo-Sculpture

For 3 months during the fall of 1978, I collaborated with an associate on a project that used a StereoRealist camera to record sequences of stereoscopic light calligraphies of the kind shown in figure 4. Inspired by a famous Gjon Mili strobe photograph showing Picasso drawing in space with a pen light, we purchased the stereo camera, collected an assortment of flashlights, colored gels, luminous objects, and objects that could be illuminated (including a number of translucent plastic buckets) and set up a kind of event space in front of the stereo camera. As many as eight successive swoops and splashes in space were superimposed on the film in the camera to create each of about 30 stereo-calligraphies. A setup not unlike the one described here would be useful for collecting a large repertory of paths of motion on which to graft varieties of images and sounds. Or a variation could be used to capture the events *in toto*–the rich colors and textures along with the underlying paths. Or alternatively, the effects and the paths could be simulated through software, or through combinations of capture and mathematical synthesis (ref. 16).

CONCLUSION

A concept of a new form of art called synesthetic art has been described, along with the characteristics of the computer-based system required for its production. The profoundly computer-oriented character of this form of art informs its relevance to themes and topics such as interactive graphics, virtual 3-D displays and projection systems, user-system ergonomics, artificial intelligence, robotics, and telerobotics. Preparing this paper has caused me to rethink, expand, and clarify my thinking on synesthetic art, and has left me even more convinced of its significance and virtual inevitability for the future of art. The progress of computer stereographics, in particular, makes it especially timely to begin thinking about actual start-up projects in stereo-synesthetics–not just a single project, but many of them, as the task is so multifarious and the directions that can be taken so diverse. In addition, this paper should assure those readers involved in fields related to spatial displays and instrumentation that aspects of NASA-sponsored research may have implications beyond NASA itself, beyond industry, business, and other obvious areas of possible application. For spatial displays are relevant to art, especially to that kind of art which is computer-based, time-variant, synesthetic, and looks forward to what is going to happen in the next century.

REFERENCES AND NOTES

[1]The importance of the technical aspect of art is especially evident in the history of Western music and the evolution of those technological marvels, the instruments comprising the modern symphony orchestra. Likewise, the history of Western painting since the Renaissance would be unthinkable except for the invention of the oil medium and its enormous virtuosity and pliability in comparison to encaustic and tempera, whose stylistic possibilities are far more constrained.

[2]My concept of synesthetic art began in the early 1940s as a form of projected kinetic sculpto-painting with music. After 15 years on the shelf, I revived and expanded the idea in 1967 on realizing that the computer made some form of illusory-projective synesthetic art not only a feasible, but a virtually inevitable, development over the long term.

[3]The Atari-based stereo goggles can be purchased for less than $150 under the name of Stereo-Tek from Antic Publishers, Inc., 524 Second Street, San Francisco, CA 94104. Better computer stereo-graphic systems having higher resolutions are also on the market.

[4]Until recently, another approach to 3-D image generation by computer was available on the market for computer-aided design and other potential applications. Called SpaceGraph, a product of Genisco Computers Corporation, the system combined a graphic display with a small vibrating mirror to generate black-and-white images within a virtual display area measuring 20x25x30 cm. Its future now seems problematic.

[5]In addition to its lack of motion parallax, stereoscopy, in respect to the components of spatial perception, almost routinely violates the way in which they normally function in synchronous gestalt patterns. As for holography, though far superior to stereoscopy "in principle," it hardly bears comparison with stereoscopy in terms of practical computer applications and potential for real-time operation.

[6]The Turing test is the classic test for artificial intelligence proposed by Alan Turing, the British mathematician and computer scientist. Questions are passed to a computer and a human respondent hidden behind a curtain and the answers are passed back in written form. When it is impossible to distinguish between the answers provided by the computer and those by the human respondent, the computer can be said to have the level of intelligence of a human being. I proposed my "Turing test" for 3-D projection as a note at the end of my article "Computer Sculpture: Six Levels of Cybernetics," Artform, May 1969.

[7]J. Chowning, "The Simulation of Moving Sound Sources," JAES, Preprint no. 726(M-3) for the 38th convention, 1970.

[8]The work, a collaboration of sculptor Sherry Healy of Chicago and Charles Bestor, professor of electronic and computer music at the University of Massachusetts at Amherst, was first presented at the Chicago International Art Exposition at Navy Pier in May 1987. The sculpture consists of four open-form modular units made of wood that as a group add up to an impressive 47- by 12- by 9-ft installation. Four sets of four speakers embedded in portions of the sculpture provide the electronic and computer-generated music, which is recorded on tape for replay every 20 min. The sounds, as they execute varied choreographic patterns between four sets of speakers, are heard differently in different parts of the work by those circulating around and through it.

[9]In my article on computer sculpture (ref. 6), I also introduced the term "transductive art" as a generic expression covering all forms of kinetic and environmental art driven by some form of energy, information, or signal originating from outside the work or system itself.

[10]Pioneering work in the automated production of computer art goes all the way back to the early 1960s and to the farsighted experiments in "generative art" carried out by a group of German aestheticians, computer scientists, and artists. The most impressive contribution in this vein so far is that of Harold Cohen of University of California at San Diego, whose program Aaron, begun in 1972, continues to expand and become increasingly intelligent, autonomous, and powerful. As a virtual surrogate of Cohen's personality as an artist, it even succeeds in demonstrating "talent."

[11]Virtually all computer-based research in art is currently in stylistics, a field that traditionally has been focused on the exhaustive description and analysis of a particular style of painting, sculpture, or architecture. Under the impact of the computer, however, this information is beginning to be tested through incorporation into programs capable of generating visually credible simulations of the style undergoing study. Through devising shape grammars appropriate to the targeted style, this technique has been applied to the architecture of Palladio (ref. 12), to the work of the Russian non-objective painter Kandinsky (ref. 13), and to that of the American abstract painter Diebenkorn (ref. 14).

[12]G. Stiny and W. Mitchell, "The Palladian Grammar," Environ. and Plan. B, vol. 5, 1978.

[13]R. Lauzzana, "A Measurement of Image Concordance Using Replacement Rules," IEEE Conference on Systems, Man, and Cybernetics, Atlanta, 1986.

[14]J. Kirsch and R. Kirsch, "Computer Grammars for the Syntactical Analysis of Paintings," in Proc. of the 26th International Congress of the History of Art, Washington, D.C., 1986.

[15]This modular composition was created for an exhibition of the University of Massachusetts at Amherst sculpture faculty held in one of the university galleries during the spring of 1978. The work, which measured 12 by 17 ft at the base, consisted of a subset of the complete 64-block set that SHAPE3D is capable of generating, manipulating, and plotting as serial-robotic compositions. The modular blocks, enlarged to conform to the proportions of those used in the design generated by SHAPE3D, were constructed of Masonite and painted white.

[16]My associate, Michael Friedman, and I alternated between creating the swaths of color-in-space for superimposing on the film, and handling the camera, which involved dropping a black cloth over the open lens while the luminous "brush" was being replaced with another for the next calligraphic event.

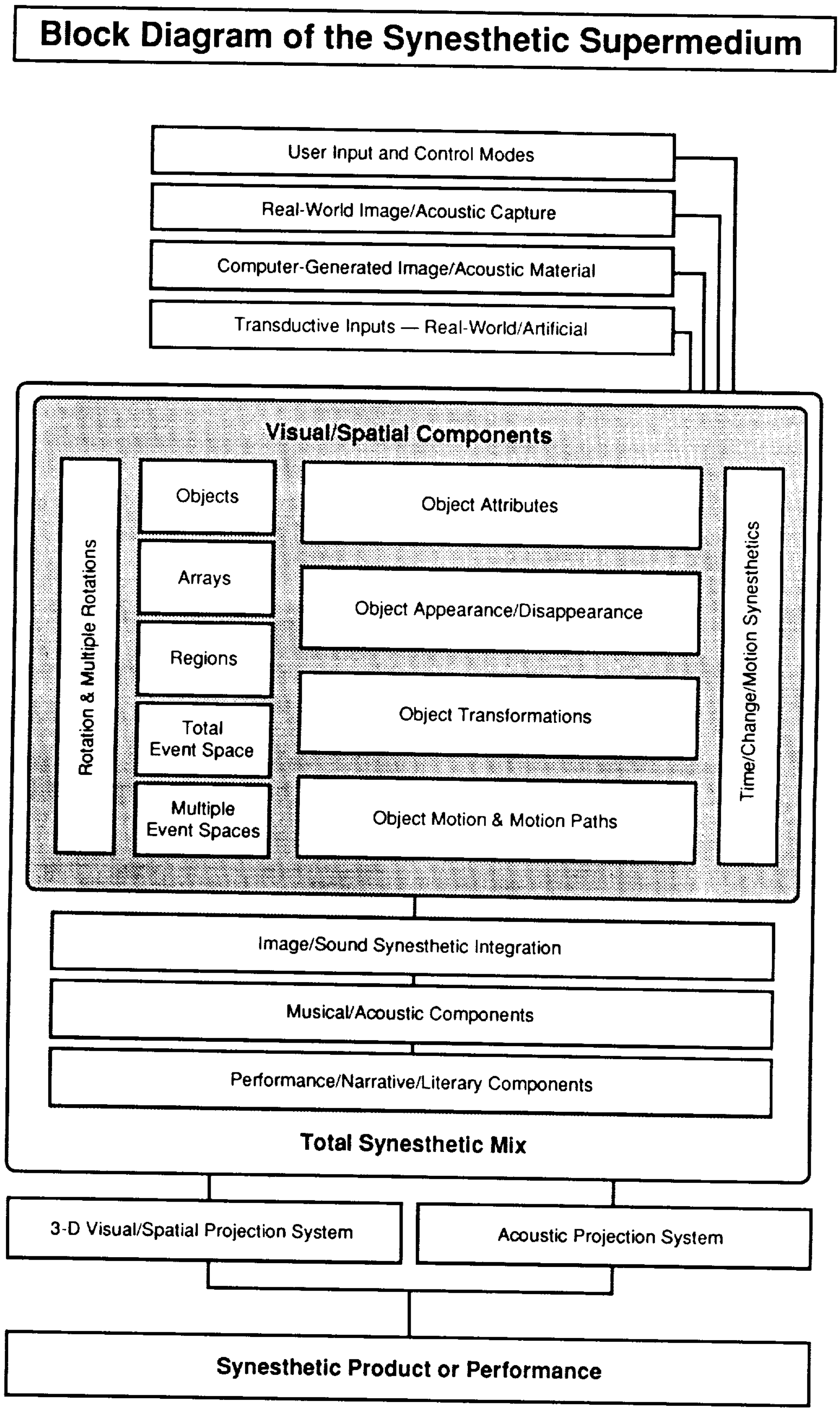

Figure 1.– Synesthetic supermedium.

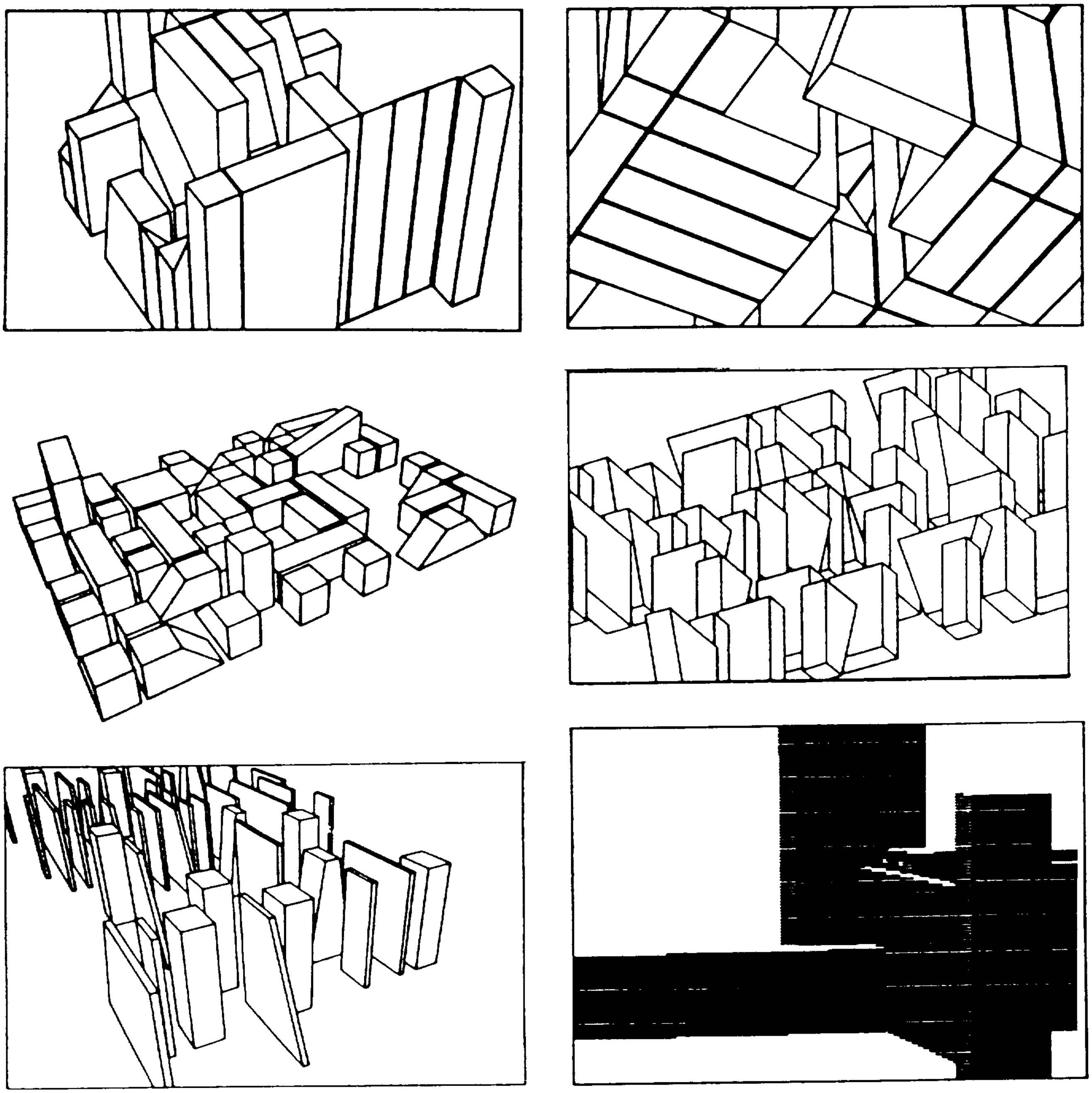

Figure 2.– Variations of serial-robotic runs.

Figure 3.– Complete sculpture chosen from a serial-robotic run of 150 compositions.

Figure 4.– Stereoscopic light calligraphy example.