

Using 3-D Models As Image Generators For Digital Fiction

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Abstract

This paper will present the concept of using 3-D modeling programs to create illustrations for works of conceptual art in new media that I call “digital fiction”. It will introduce my early work using mathematical processes, and explain how this differs from conventional illustration in that the artist creates processes rather than finished works and extracts the images from the output of those processes. Processes can include generative algorithms, which can be used to create 3-D models, animations, or images for the illustrations themselves and explorations of virtual environments which can generate images based on various points of view. Examples will be presented from my works **Abducted By Aliens**, **I Was Flown Through A City Of Mirrors** and **Inside Klein’s Doughnuts I remembered a new bottle**. Finally, it will present my recent work **...of Smoke and Mirrors**, which I call “a mathematical metafiction.”

1. Introduction

1.1 Beginnings. When I began working with CAD programs in the 1990s, the 3-D functions of the software were not fully integrated with the 2-D drafting capabilities. I still used 2-D drawings exclusively in my design work, drafting numerous plans and elevations for each project. I used 3-D models, separately, to create illustrations for designs and for architectural concepts. I began combining text and models in what were essentially 3-D bubble diagrams. (A bubble diagram is an architectural tool in which shapes are used to illustrate functional relationships of spaces.) When I wanted to illustrate the idea that built environments are created from chaotic processes, I created a number of 3-D models by applying a series of algorithms to a simple iconic house diagram. I used renderings of these models to illustrate text that was not descriptive and academic, but narrative, whimsical, and multi-coded. The finished work *Generations of a House* was conceptual and metaphoric.

1.2 Illustrations. The normal process of illustration involves creating a 2-D image. Traditionally this was done with the conventional media of drawing or painting. Nowadays illustrations can be created with digital drawing tools, such as Adobe Illustrator®. Although these programs may allow 3-D effects to be added to certain elements (it would be a stretch to call these “objects”), the drawing environment is still only two dimensional. Effects such as lights, materials, and shading must be interpreted by the artist to create final renderings. As in conventional media the artist directly controls the result. 3-D modeling programs are capable of creating virtual objects that are fully renderable from any point of view. The artist assigns materials and adds lights. The program creates renderings using these parameters. Renderings of these objects can be created and used as illustrations in various ways. The artist controls the processes and selects the results.

2. Image Generators

2.1 Generative Algorithms. My own work with algorithms in art began with an interest in the role of cha-

otic and semi-chaotic forces in shaping the built environment. I created illustrations using a mathematical algorithm to generate 3-D objects. It was a spiral with a limited number of parameters: the spiral axis, the number of copies, degrees of rotation, total offset, and a scale factor. Slight changes in the parameters could produce major changes in the outcome. I was more interested in the changes than the individual objects. I changed the outcome by adjusting the parameters. Since small parameter changes were amplified, the generations mimicked chaotic processes on a very elementary level, but the outcomes were fairly predictable. I selected the ones that pleased me and rejected the ones that did not. I could just as easily have created algorithms whose results I could not anticipate. This would generate images that I could either use or reject, but I would have had no a priori control. If the algorithms create animations rather than models, there is an image generated for each frame. This produces not only the image of the finished model but images of all the intermediate stages in its creation. Algorithms can be used, as I did, to produce finished images for illustrations. Or they can be used to generate objects that can be further manipulated to create the finished images.

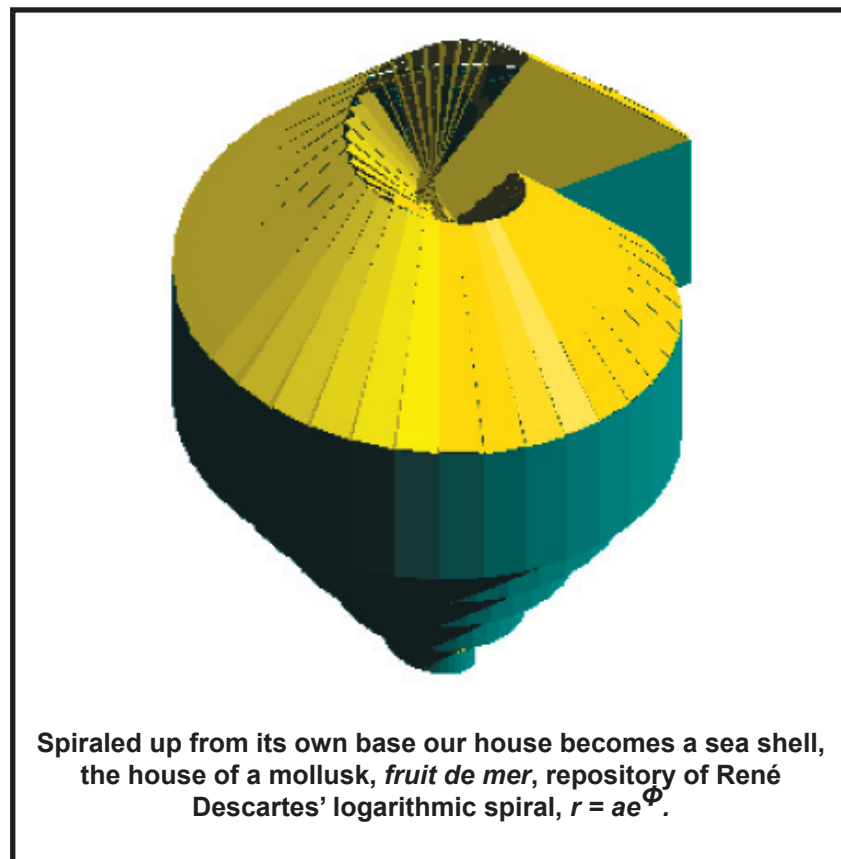


Figure 1: *A sample page from the work **Generations of a House** . The model was created by an algorithm acting on a simple house icon in order to illustrate the idea that the built environment is controlled by generative rules and is chaotic in the mathematical sense. The text, which is whimsical but not trivial, is a commentary on the nature of language and space.*

2.2 Explorations. A virtual object needs to be manipulated to produce images. Once the object is created and placed in an environment, a view needs to be found that produces an image suitable for an illustration. I call the process of finding this view an “exploration”. An exploration can involve manipulation of the object itself, by rotation or adjustment of its position. This exploration changes the relationship of the object to its virtual environment. In the second type of exploration the point of view itself would change with respect to

both the object and its environment. Just as we can move around and view an object from different angles, we can move a virtual point of view to various locations. Renderings are created with a virtual camera. One of the greatest powers of virtual imagery is that points of view can easily be assumed that would otherwise be unimaginable. Since scale is relative and depth of field is not an issue, the camera can be placed anywhere. Virtual objects have no mass and no inherent orientation, so they can be explored from every conceivable direction including from the inside. The camera itself is invisible and will not interfere in any way with the viewing.

2.3 Animated Explorations. Virtual reality programs would seem to be an ideal method of manually exploring environments, but when a virtual environment is complex the rendering process can be very slow. Renderings of virtual environments can be quite sensitive to changes in point of view. In such cases explorations can be done with digital animation. Just like conventional animation, digital animation renders a number of frames that are played back as a continuous video. Individual frames can be saved as the animation is created or later extracted from the video file. The artist adjusts the parameters of an animation algorithm, sets the process in motion, and later extracts individual frames for use as illustrations.

3. Digital Fiction

3.1 The City of Mirrors. In 2002 I modeled a high rise building and decided to put it into a virtual cityscape in order to make an animation of a drive through the streets. Some of the buildings were carefully modeled, but most were simple geometric shapes: boxes, cylinders, and cones. To these I assigned default materials. I created a path through the streets and moved a camera along that path. I was experimenting with different camera movements and this virtual city provided a setting. Later, when I wanted to try animating a roller coaster, I used this city again. This time the camera path was much more complicated with more turns, ups and downs, and varying speeds. Although there was no track visible for the roller coaster, it did provide a simulated ride through the city. This too was a successful experiment but without a visible track or vehicle, the animation felt somewhat empty.

I set the project aside for awhile and returned to it with the intent of introducing some kind of vehicle into the animation; a UFO seemed like a good idea. I realized that a passenger in a vehicle never actually sees it entirely, so I attached it to the camera at a point slightly within the view. Realizing that this would not add much interest to the animation and not wanting to simply show the UFO flying through the city, I decided to make many of the surfaces in the city from highly reflective materials so that it could be seen in the reflections. To make sure that there was no ambiguity I put the letters "UFO" on the side so that they would be reflected backwards in the mirrors. At this time I still had nothing more in mind than the animation. I recorded the animation and the result was interesting though not profound; but when I looked at individual frames, I realized that there were many very interesting images.

3.2 Critical Filters. A number of things have troubled me about digital art. There seems to be no shortage of people who call their digital works art, but I have often wondered what kind of audience there really is for most of this stuff. With the Internet there are means of distribution easily available to anyone with a huge potential audience. But potential audience does not equate to an actual audience. I saw other serious questions about the marketability of digital art. This brings up the age old question "What is it that makes something art?" Sidestepping potentially endless debates about taste, aesthetics, beauty, personal opinion, artist's intent, etc., I would suggest that art is defined through the mechanism of critical filters. I would suggest that these are a very loose consensus of opinions held by artists, art professionals, journalists, critics, and the public. Art that does not encounter critical filters has a hard time being taken seriously.

Reproduction of computer works on paper seems an ideal bridge between old and new media. These can then be dealt with in ordinary settings and subjected to ordinary critical filters. While it is possible with a computer to generate a plethora of interesting images, it seems somewhat disingenuous to just print these out and call them art. In my own work I could not see the images standing alone. Having already completed a work that included text, I decided to include text in the prints.

3.3 Abducted by Aliens. At this point it was my intent to select some of the most interesting images from the UFO video, add text, and produce a number of limited edition prints. I selected 11 images and combined them with personal stories of alien abductees, and produced a proof print of each. I had planned for each print to be an individual work, but when I saw the entire collection I decided to make it a set. For flexibility of display I created a set of 12. There is no narrative order to the text but frame numbers of the individual images are included. Titles are very important to me, so after careful consideration, I called the work **Abducted by Aliens, I Was Flown through a City of Mirrors.**

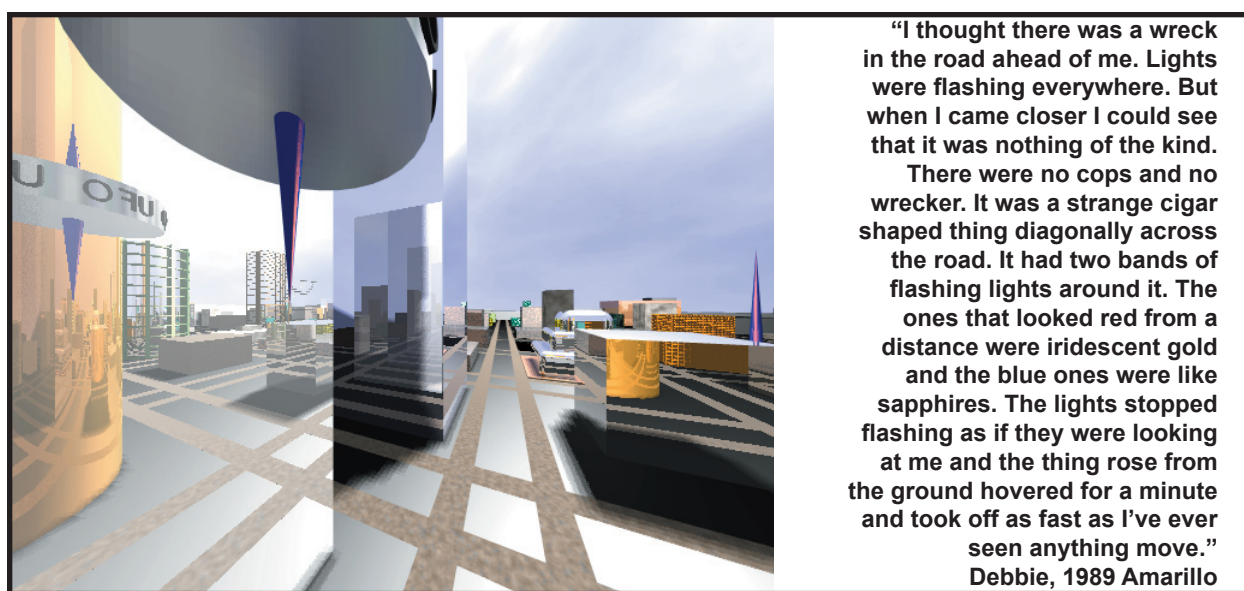


Figure 2: *A sample page from **Abducted by Aliens, I was Flown through a City of Mirrors**. The images are frames from a computer animation of the voyage of a UFO through an environment constructed mostly of mirrored objects. The text consists of a number of pseduo-accounts of encounters with aliens. Although this work is not particularly mathematical, it initiated my interest in highly reflective objects which I continue to explore with mirrored hyperobjects.*

4. Hyperobjects

4.1 Virtual Hyperobjects. The analogy of a cube within a cube representing a fourth dimensional cube is familiar, but until recently representing hyperobjects in 3-D has been problematic. A cube, for example, could only be drawn in 2-D, or “drawn” in 3-D by constructing a wire-frame model. With the advent of computers and powerful 3-D modeling and rendering tools, it has become possible to create virtual hyperobjects. Although practically these can only be presented on a 2-D screen, walk-through and examine tools allow them to behave very much as true 3-D objects. Furthermore, view points can be created without the intrusion of a viewer and can easily be placed inside the object itself. I thought an interesting project would be constructing and exploring these virtual hyperobjects. (To avoid ambiguity I have found it to be expedient to name hyperobjects after the objects in the representation rather than the higher dimensional object being represented. By this convention a sphere within a sphere would be a hypersphere; a cylinder within a cylinder would be a hypercylinder, etc.)

4.2 Adding Another Dimension. These virtual hyperobjects were conceptually pure but they proved to be visually uninteresting. So, using artistic license, I represented the fourth dimension with the metaphor of a mirror. This can be done in a 3-D computer model simply by assigning a mirror material. An additional advantage of the computer model is that there is no intrusion of the viewer's reflection. Although this metaphor makes figurative sense, I haven't tried to defend it in the logic of the 2-3-4-D analogy. In the artistic sense it doesn't violate the ontological purity of the virtual hyperobject. I didn't create this concept of the virtual hyperobject and then make the objects. Rather, I created the objects, found them extremely interesting, and then refined the concept as post factum justification.

4.3 Exploring Hyperobjects. Images of reflective hyperobjects change radically with point of view. It would be nice to be able to simply create a virtual reality hyperobject, move through it, and select interesting images. But, because of the complexity of the reflections (they often produce fractal images), draft rendering is useless and quality rendering is very tedious. For this I find animated explorations a useful solution. I can create the model, create a camera path, run the animation, let the computer do the work, and come back and have a whole series of images.

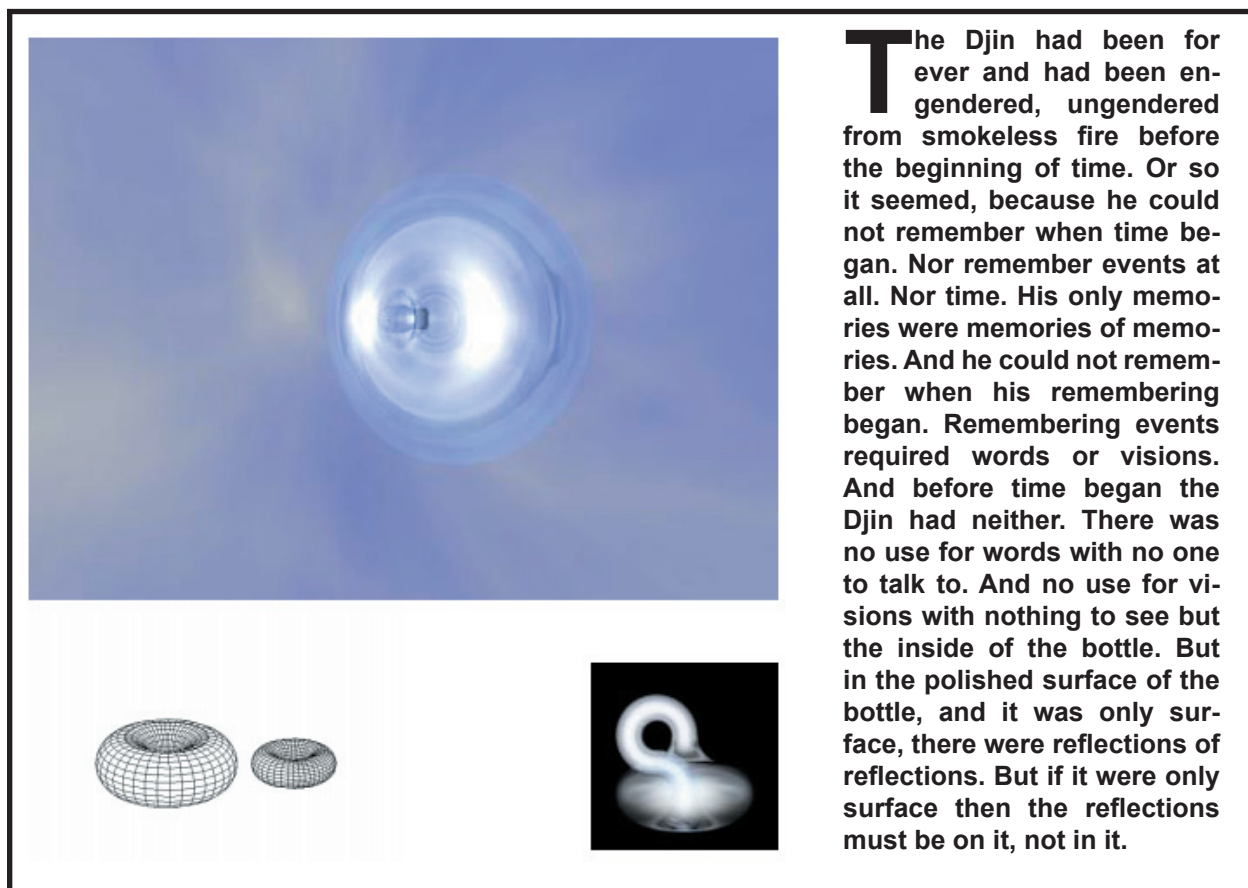


Figure 3: Sample page from *Inside Klein's Doughnuts I remembered a new bottle*. This work, which was intended as an animated exploration of a Klein Bottle, led to the discovery of a new construction of a Klein Bottle from two tori. The upper image is a frame from the exploration video. The lower images are from animations of the construction and rotation of the Simplified Klein Bottle. The text, written in the form of a fable, deals with the relationships of mathematics, physical reality and symbols, including language. In doing so it touches on the big bang, Gödel's theorem, and the nature of time, space and reality.

4.4 The Klein Bottle. I thought it would be interesting to see what a Klein bottle looked like from the inside, rendered like these other hyperobjects. In the course of this project I discovered a simplified construction for a Klein bottle from two tori. After constructing the bottle I created a camera path and filmed an animated exploration. The nature of the object immediately suggested an idea for accompanying text, so I combined 12 images with a story of a Genie to create a conceptual series titled **Inside Klein's Doughnuts I remembered a new bottle**. In this work the text has a narrative continuity and the images, viewed in succession, create a mini-flip-book version of the video.

4.5 The Truth of Fiction. We constantly communicate with metaphors. The nature of language is such that narrative stories are often the most powerful way of communicating great truths. Philosophers, anthropologists, and cognitive scientists are researching the ways that narratives affect our thinking and make us human. The nature of the arts, including literature, is such that simple expressions can contain multiple meanings. Scientific and technical writing and illustration must avoid ambiguity; art and literature thrive on it and, indeed, may be able to communicate better because they can be read on many levels. Currently “new media” is the term of choice to describe computer art, digital animation, interactive art, Internet-based art, etc. It is a good general term to use in generalizations, but is unclear when applied to its own specific genres. This leaves it open for artists to define their own work. I’ve come to call my work in digital images and text, that coexist in both electronic and print media, “digital fiction”.

5. The Hyperbolicube: A Mathematical Metafiction

5.1 The True Origin of the Hyperbolicube. While experimenting with images produced inside various reflective hyperobjects, I became intrigued with using hyperbolic surfaces. I arranged six hyperbolic disks so that each of their edges would form a circle inscribed on the face of a cube. The convex side of the disk faced inward. The cube itself was never included in this figure. I then created a sphere, centered on this cube, so that each of the circles would fall on its surface. Subtracting the disks from the sphere created a figure of six concave hyperbolic disks connected by eight spherical triangles. Prompted to name the file upon saving, I dubbed it “hyperbolicube”. Rendered as a mirrored surface it produced interesting images, but I didn’t regard the object itself as particularly unique.

Later, in looking for material for another digital fiction, I returned to this file. The name seemed intriguing so I did an Internet search for the word and found that, lo and behold, it didn’t exist. I had created, if not a new mathematical object, at least a name for one. It seemed to me that the discovery of a fictitious mathematical object should be reported in a mock scientific publication. Of Greek origin the word “catoptrics” refers to the branch of optics dealing with the creation of images by mirrors. A little research into Greek gave me a companion word, “capnotic”. Thus was born, the Journal of Capnotic and Catoptric Studies, or in plain English, the Journal...

5.2 ...of Smoke and Mirrors. The work consists of reproductions of the cover of the journal and a five page article on “The History of the Hyperbolicube.” Since the hyperbolicube as an object is not especially interesting, it seemed logical to embellish it with a colorful, if fictitious, history. The work traces the history of the hyperbolicube from ancient Greek origins, through Rome to Renaissance Italy, from medieval Spain to modern mathematics. It uses word play and puns in several languages, anachronisms, and references to the histories of mathematics, art, architecture, among others. It includes puzzles and some very obscure references. In its final pages this digital fiction becomes metafiction when it references itself and plays with the ontology of its own digital images. Although I followed my wife’s well-taken point that I delete the really bad puns, I don’t think art needs to be serious to be taken seriously. The English title of the art work

makes clear that this is a work of fiction. The paper version of this work consists of six framed prints, that appear to be pages torn from a magazine. Most of the illustrations were created using explorations of 3-D models, although some are borrowed.

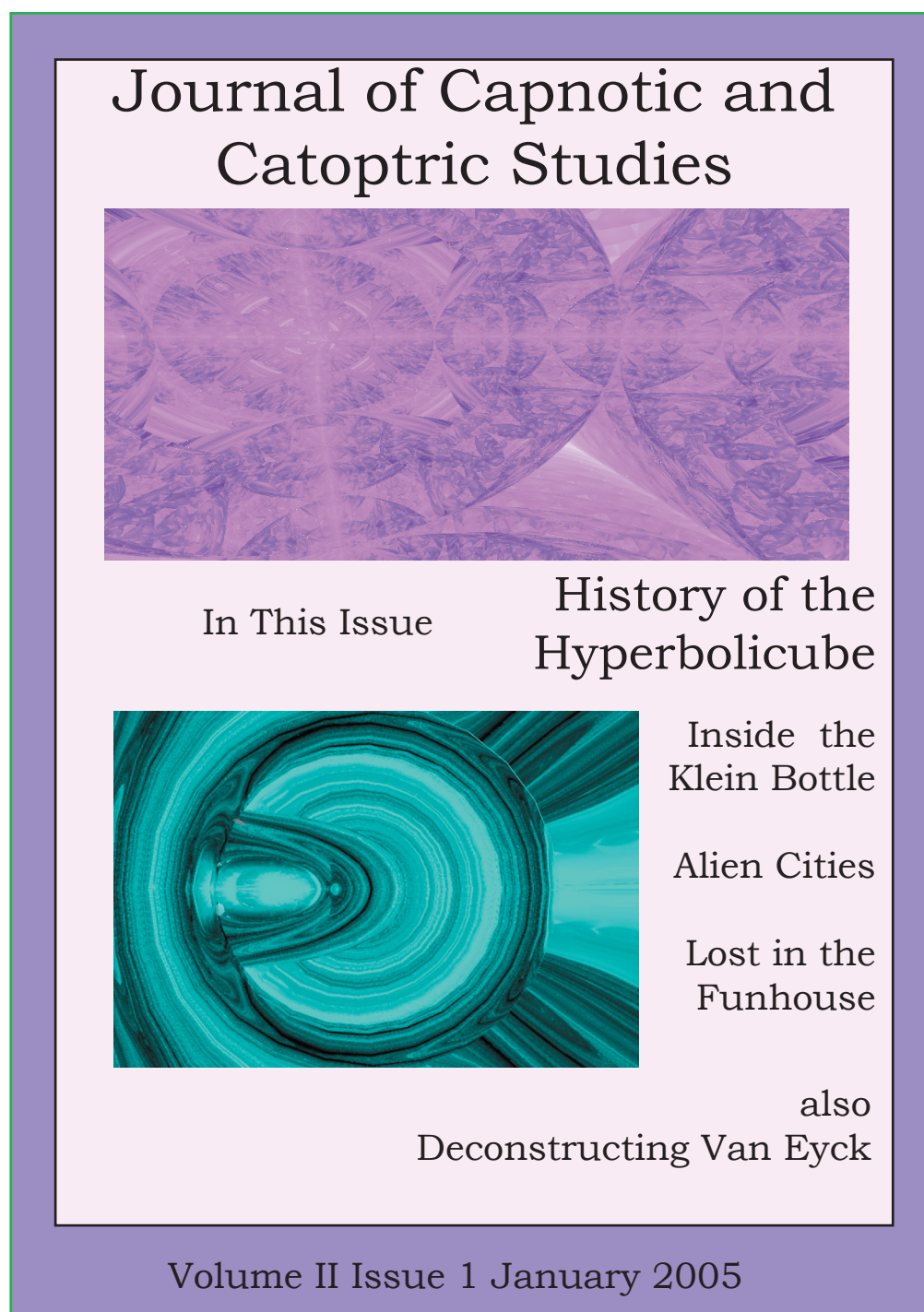
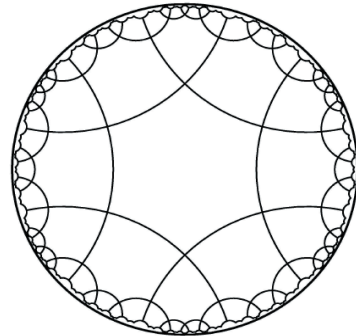


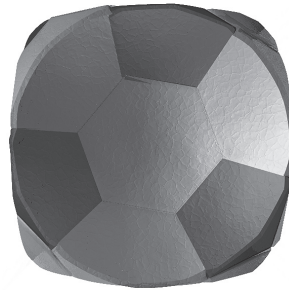
Figure 4: *The first page of the work ...of smoke and mirrors. This work is presented in the form of pages torn from a pseudo-academic journal. The title of the journal refers to the study of smoke and mirrors, in other words illusions. The fractal image at the top was produced inside of the hyperbolicube. The other images is of the inside of the Simplified Klein Bottle. The lead article is the only one included in this piece; most of the other titles refer to other works of mine. The date is intended to be adjusted to the current exhibition date.*

Figure 5: A sample page from the work *...of smoke and mirrors*. For this work I created a mathematical object which I call "the hyperbolicube", because it consists of six mirrored hyperbolic surfaces arranged as if they were on the sides of a cube. The intention was to generate fractal images by viewing it from inside. (See Figure 4.) Because I feel that these images, while aesthetically and intellectually interesting, have no inherent artistic value, I incorporated them into a larger conceptual work in which I create a fictional origin for the hyperbolicube and trace it through history from ancient times to the present. I also borrow images from other sources. Characters in this narrative are real and fictional. Recurring themes include art, geometry, architecture, language, and the epistemology of history. Because the nature of language is so important to me, the work includes puns in several languages. These are intended not as mere entertainments, but to deconstruct the symbolic frame on which serious ideas are built. The densely coded text which contains puzzles, encryptions, paradoxes, and anachronisms ultimately refers to the work itself. In this self-referential sense it is a metafiction.

French Connections: In 1776 the French mathematician Jean Laplace, brother of the now more famous Pierre Simon Laplace, realized that a sphericube could be created with hyperbolic disks. This became the true hyperbolicube. Not prone to hyperbole, Jean Laplace did not hype his discovery, so it remains unknown to this day as does his hyperbolic soccer ball which packs well but cannot be used to play soccer. (Below)

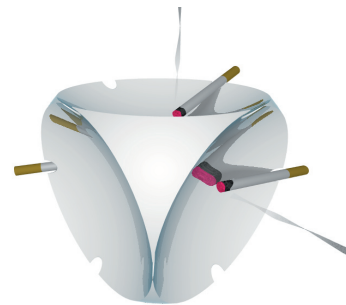


Modernism: It is widely presumed that French mathematician Henri Poincaré was inspired by the cubed soccer ball to create tessellations of the hyperbolic plane. (Above) In the 1920s the shape became extremely popular with modernist designers. It was incorporated into numerous industrial designs including the famous six sided ashtray. (Below)



Laplace Museum Paris

Their great nephew Jean Simon Laplace, a neobaroque city planner, drew the street plan for Quebec. The plan called for a round square which Jean Simon Laplace knew was an oxymoron, so he briefly considered using the shape of hyperbolisquare (a 2 dimensional section of the hyperbolicube), but rejected this in favor of changing the language of Quebec to French and eliminating the oxymoronic conflict. This change became known as the Laplace transform.



Collection of the Author

Note on the illustrations. The original works of art referenced in this paper were produced with various computer programs. The text included within the illustrations is an essential part of the art. This paper was composed using Adobe InDesign®. For the sake of quality of reproduction some of the excerpts from these art works have been slightly reformatted within the InDesign® document. The content is consistent with the original works.

References

- [1] George Gamow, *One, Two, Three...Infinity*, The Viking Press, New York, 1962
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