YLEM Journal

Artists Using Science & Technology
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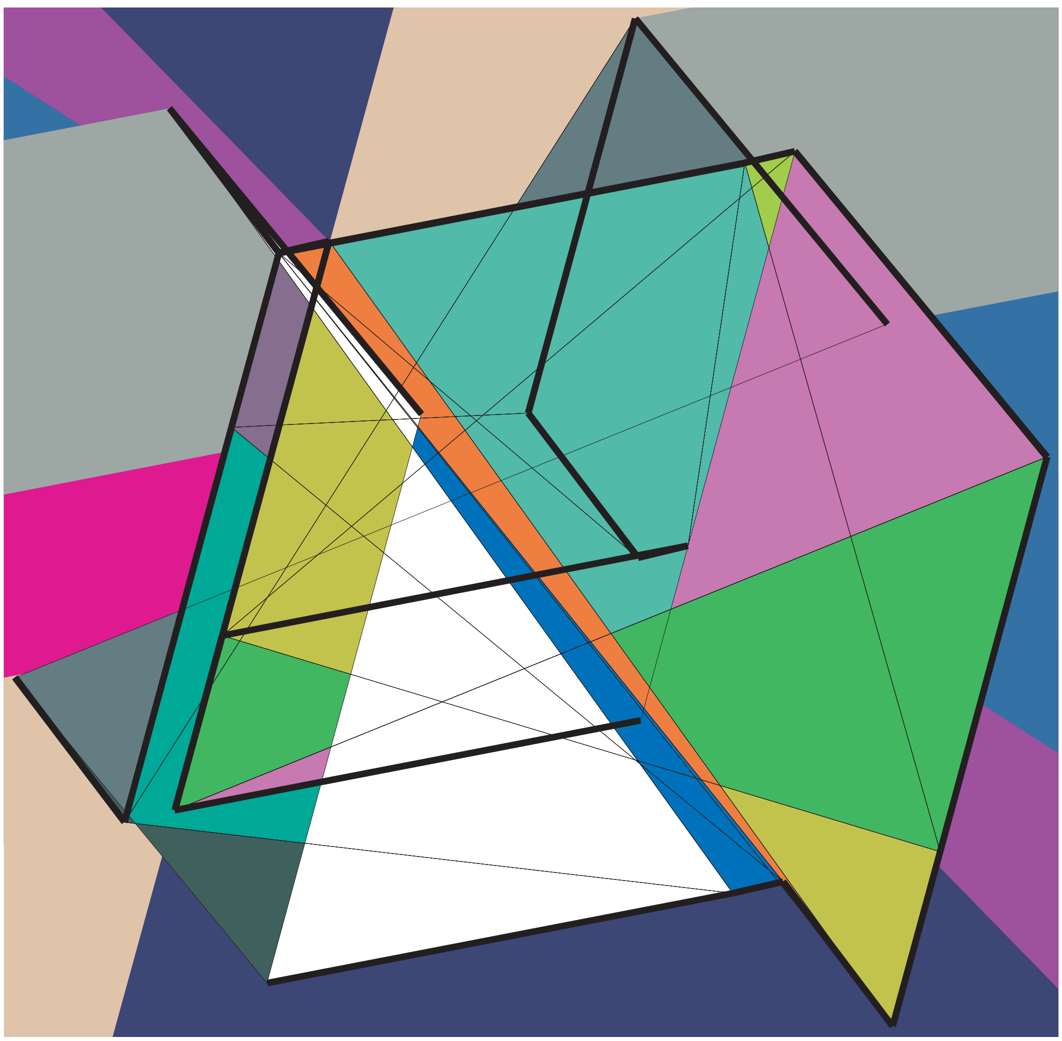
Art and Programming



Manfred Mohr, P707/F

formerly YLEM newsletter

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From the Editor
Anna Ursyn

Art and programming is the leading theme for this issue of Ylem because programs may serve for creating traditional forms of art and design, such as drawing, painting, sculpture, photography, as well as for interactive arts including installations, web-based and multimedia projects, 3D animation, performances, and experimental works. A photo-manipulated scanned image-based artwork or an image created with the use of a graphic or painting software by drawing pictures on the computer screen may be examples of many other ways of creating art that utilize technology without writing programs. One may apply digital multimedia packages, videotape animated sequences of those images immersed in a computer graphics-created environment, and stimulate real time interactive communication through art. Mathematically generated images with the use of computer programs and scene description languages may yield a projection of the form on a surface, provide three-dimensional, sometimes animated vision of the image, bring in a transformation into the visualization system or the virtual reality 3D immersive world or enable developing interrelationships between different media, not to mention numerous other possibilities. Due to the compositional process of intermedia that work on structures that are shared or translated between different media, both the new forms and disciplines and the meaning of the formalized media can be constructed. Cross-modal approaches to the intersection of computation and thought representation provide expressive possibilities for the visualization of images, forms, music, poetics, interactive fiction and other metaphors of inter-sensory synesthetic experience in the real time interactive systems, enable exploring system behaviors, recombinant productions, enhance virtual communication over the web. However, realities created with the use of programming refer to our imagination and experience based on physiological reality of the mind. The sense of mathematical beauty is perceived not only by the well-trained eye of the mathematician. Sculptors render appealing forms which are, sometimes even without their knowledge, perfectly fitting to mathematical equations. Many artists create with the use of programming shapes and forms representing the beauty of mathematics: many-dimensional spaces, hyperbolic planes, fractal-like repetitions, as well as intriguing natural forms that obey the rules of equations, such as the beautiful Nautilus shell.

The discourse about this theme is continued in the following articles: Paul Fishwick (University of Florida) contributed with his article “Aesthetic Computing: Making Artistic Mathematics & Software,” and Aaron Wolf Baum, Ph.D. with an article “Loving the Logic of the Alien.” The selection of electronic art created by artists using programing for their art creation, along with their short statements, provide some examples of various personal styles and ways of production.

Special thanks to Vanessa Meier for proofreading this issue.

YLEM Forum:
Secrets of Silicon Valley

Wednesday, September 18, 7-9 pm
The Production Studio at The Exploratorium
3601 Lyon St., San Francisco, CA 94123

To get into the YLEM meeting free, mention YLEM at the entrance desk. Open to the public, wheelchair accessible. Sponsored by YLEM: Artists Using Science and Technology (To visit museum exhibit area, pay admission: $10 Adult $6 Youth)

See The Secrets of Silicon Valley, the first and only film to take a critical look at the social impact of the new millenium's high technology. It will be presented by Magda Escobar, Executive Director of Plugged In, a community technology center in low-income East Palo Alto. She has been named one of Ms. Magazine's Women of the Year for 2001.

Secrets of Silicon Valley is a shocking expose of the hidden downsides of the Internet revolution and also a funny and moving meditation on America's love affair with technology. Told without narration, the film chronicles a tumultuous year in the lives of two young activists grappling with rapid social change and the meaning of globalization on their own doorsteps.

Follow Plugged In as it struggles to find a new home and receive and find unexpected help from Hewlett-Packard and visit from an ebullient President Clinton. Established in 1992, it has four programs: a drop-in community production studio, an arts and technology program for children, a web design business run by teenagers, and a community network. Plugged In’s mission is to ensure that everyone in East Palo Alto has the opportunity to fully benefit from the technological revolution.

Follow Raj Jayadev, a Manpower, Inc. temporary worker at a Hewlett-Packard plant, as he encourages the "temps" there to challenge health and safety conditions. He gets fired for this, but finds surprising and funny ways to take the controversy to the Internet, the public and the press.

Follow tons of computers to their demise in Hewlett-Packard’s state-of-the-art recycling plant near Sacramento, and learn of toxic substances in them.

Contact: Trudy Reagan, 650-856-9593,
trudy.myrrh@stanfordalumni.org
Complete information listed at
http://www.ylem.org, click on "events" and then "ylem forums"

Helaman Ferguson

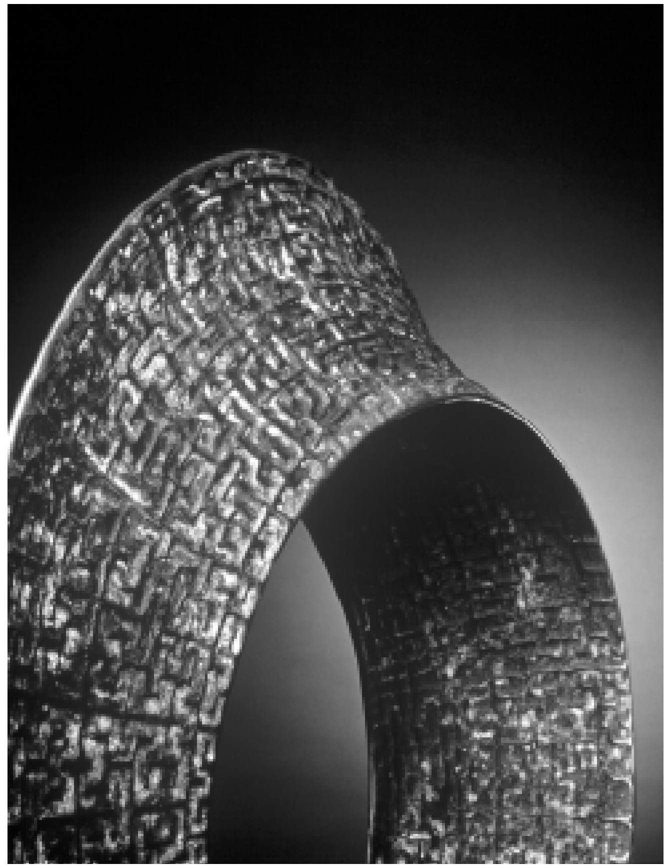
Helaman Ferguson is transferring thought forms formulated in terms of topological mathematics to physical materials using a method of telecarving where geometric forms drawn on a computer screen are translated into instructions on direct-carving the stone. To get the expected external appearance to his art forms, the sculptor uses both traditional tools, such as a hammer, a chisel, and a pneumatic hammer, and the computer programmed tools. The artist stated: "I use mathematics as a powerful aesthetic design language for vital archetypal images. I am interested in affirming pure mathematical thought in unpredictable physical form." (Peterson, 1990). Ferguson's sculptures include tori and double tori, nonorientable surfaces, wild spheres, Mobius strips, trefoil knots, cross-cap surfaces, and other forms. Other mathematical language descriptions of these categories are: matrix representations, surface immersions, wild embedding. Those names come from topology, which relates to the mathematical approach to examining characteristics of geometrical shapes and involves questions of category and equality of forms.

Below is a three-part artist's statement in the first person.

1. How I was motivated to become a sculptor:

I suppose I generate evidence of life in the face of death. My natural father was a visual artist, my natural mother a model in an art school in Los Angeles. I was born in Salt Lake City, located on high arid mountain plateau. My mother was killed by lightning when I was three, my father drafted into the Pacific theater of World War II. Life has risks for all of us. My adopted father was an Irish stonemason, my adopted mother from colonies in northern Mexico. They graciously raised me in upstate New York. My genetic nature was art and science, my environmental nurture was learning to work with my hands and to appreciate raw materials of little apparent value. As a kid I was pretty raw myself. As I went through the New York Regents public school system in the post-Sputnik era I had many opportunities to study science. I chose to do creative math in a liberal arts college rather than an engineering school. Our society tends to compartmentalize people and professions, maybe with good reasons. Overcoming this compartmentalization has been a continuing battle for me. I refuse to be diminished by being described as just a mathematician, by being described as just a sculptor—I persist in both. Fortunately for me our society is diverse enough to permit both.

It is very exciting for me to learn a new stone. I have one now, one billion years old, waiting for me to stop writing here.



Helaman Ferguson, Umbilic Torus NC

2. What I can share about my creative process:

At this moment I see two parts, mental and physical. It is important to me that they are hard to separate. Mental: Mathematics, its ideas, symbols, and equations are an essential part of my personal design language. Much of my sculptural body of work celebrates the remarkable achievements of mathematics as an abstract art form—a human activity spanning thousands of years. These ideas combined with my tools and materials take the form of an undeniable will.

Physical: my aesthetic choice of raw materials tends to be stone from geological activity spanning millions of years. It is very exciting for me to learn a new stone. I have one now, one billion years old, waiting for me to stop writing here. I use many different kinds of specialized tools, including computers, virtual image projection from equations, tool position and orientation monitoring, air hammers and drills, carbide cutters, diamond corers and saws, diamond chains, cables, pulleys, hydraulic rams, gantry cranes. This is a high-risk environment of air, electricity, water, dust, and chips that calls for special breathing apparatus, vision and hearing protection, various kinds of body armor and insulation. Definitely postmodern man. I use hammer and chisel too, but while a lot has changed, it is the same as when our ancestors banged a soft rock with a hard rock and made a magical form. My mathematical forms arrive by my subtractive process: my computer tool position and orientation monitoring system does not do the cutting work, I do. The system gives me quantitative information. I want it this way because I learn the mathematical form that no one has ever seen, touched, felt, walked around, or crawled through. This learning from computed quantitative information is like learning a piece of music or choreographic sequence by heart; having learned the new form it becomes part of my sculptural repertoire, independent now of the computer system. My studio is a door or canal through which mathematically designed things take form in geological materials.

Helaman Ferguson, Four Canoes: 2^5

3. Risks cause communities to respond in ways not necessarily convenient for individual members of those communities.

My family heritage is of pioneers and colonizers; indeed I have found it important to leave the colonies of my origins and take up residence in older, more deeply-rooted communities, which can support my work in emotional as well as material ways. Even so, carving stone, even with computers as I do, involves operating in a harsh environment. In the process of carving stone I undo, by violence, millions of years of geological material-forming processes. With each new stone I carve I learn how to undo its geology and at the same time to convolve it with mathematical ideas. What worthless-looking rocks await my hand and mind to transform them to beautiful and irresistible artifacts with my imprint of timeless mathematical theorems?

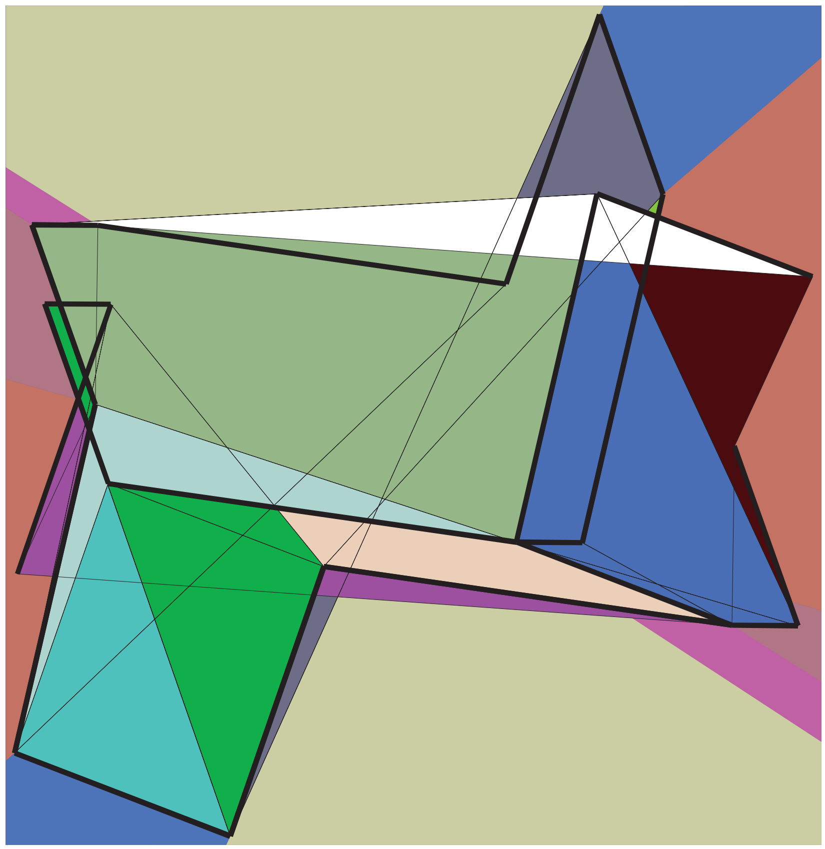
Helaman Ferguson, Fibonacci Fountain: $|((1+5^{(1/2)})/2)^{(1/Z)}|$
Maryland Science And Tecnhology Center
Bowie, Maryland, 2002

Manfred Mohr
Artist's statement

In my artistic development I did not have the typical constructivist background. I was an action painter and jazz musician. Through a development of consciousness, I detached myself from spontaneous expressions, and, in the mid 60's, turned to a more systematic, geometric form of expression. It was mainly the writings of the German philosopher Max Bense and the French composer Pierre Barbaud that radically changed my thinking—pointing to a rational construction of art. Since 1973, in my research, I have been concentrating on fracturing the symmetry of a cube (including since 1978 n-dimensional hypercubes), using the structure of the cube as a "system" and "alphabet".

The disturbance or disintegration of symmetry is the basic generator of new constructions and relationships.

The computer became a physical and intellectual extension in the process of creating my art. I write computer algorithms, i.e., rules that calculate and then generate the work which could not be realized in any other way. It is not necessarily the system or the logic I want to present in my work, but the visual invention that results from it. My artistic goal is reached, when a finished work can visually dissociate itself from its logical content and convincingly stand as an independent abstract entity. Over the past two decades I had many solo and group shows in galleries and museums world-wide. In 1994, the first comprehensive monograph (hardcover, 240 pages) about my work was published by Waser-Verlag (ISBN 3-908080-39-8) in Zürich.



Manfred Mohr, P707/D

In Manfred Mohr's mathematically generated art, inventing rules (algorithms) makes the starting point of artist's research aimed to provoke the spectator to investigate. Through fracturing the symmetry of a cube or a n-dimensional hypercube, he creates the two-dimensional signs resulting from the projection of the lines of the cubes. However, he wants to present the visual invention that results from the system or the logic, so his artistic goal is reached when a finished work can visually dissociate itself from its logical content and convincingly stand as an independent abstract entity.

After working for more than three decades in black and white, my new work (1999 -) the workphase space.color includes color. The steady increase of complexity in my work forced me to reconsider the use of this b/w binary system in order to find a more adequate visual expression. Adding colors to my work describes spatial relationships that are not based on color theory. The colors should be seen as random elements, showing through their differentiation the complexity and spatial ambiguity essential to my work. My new work is shown as inkjet images, and also on a flat screen hanging on a wall presenting a slow-motion animation, so that day after day a different image appears. This workphase is based on the 6-dimensional hypercube.

This work phase (1991-92) is based on the 6-dimensional hyper-cube. This geometrically defined structure has 32 diagonals. The two endpoints of each diagonal lie diametrically opposite in the structure. A "diagonal-path" is the connection of two such diametric points through the network of edges of this complex structure. In a 6-D hyper-cube, each of these 32 diagonals have 720 different "diagonal-paths". For each "Laserglyph" a random selection of four "diagonal-paths" from this repertoire of 23040 (32x720) possible paths is made. The 2-D dimensional projection of such groups of four are cut out of a metal plate by a laser to form a relief.

Aesthetic Computing: Making Artistic Mathematics & Software

Paul Fishwick, University of Florida
http://www.cise.ufl.edu/~fishwick

Introduction

Computer art represents the use of the digital computer to create artistic products, by employing technology in the service of art. Its clearest societal presence is at the movie theatre, where computer graphics directly support the art of movie production. The bridge between computing and art also has other connotations. Creating software has often been termed an art, but by this term, most are referring to its craft-like qualities; it is the process that is likened to art, and not so much the product. However, Knuth has developed a significant agenda in his goals to elucidate a new sort of software aesthetic—a return to a form of software calligraphy [1]. That is, to create software is to participate in a kind of craft, an art form. However, most software has little in the way of its external appearances with art—there are few connections between the usual products of art found in art galleries or on the web and the typical programming language. Most programming is fairly minimal in representation. This minimalism is inherited from mathematics, which preceded it.

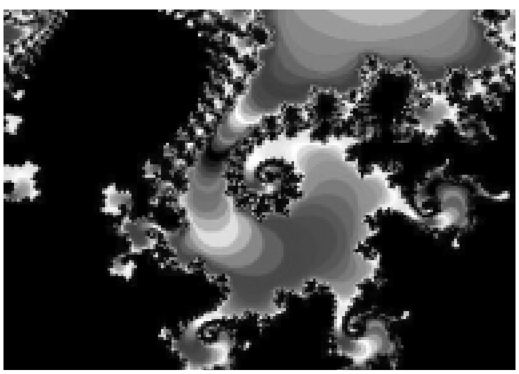


Figure 1: Mandelbrot set segment created using Thorsen's Java applet http://www.thorsen.priv.no/services/mandelbrot (X = -.1714806 and Y= -0.6508634)

Before continuing on the subject of software, and its notation, we should recognize that the practice of computing is about several stages, such as 1) designing a program, 2) providing input to a program, and finally 3) executing the program. Moreover, a program can be formalized as a mathematical expression such as a lambda function or production system, and so ultimately, the problem of representing programs regresses into one of mathematical notation. Each of the previous three program stages has the potential for artistic influence. The area of execution is likely the most successful in terms of artistic influence, since early on, mathematics has demonstrated its facility for its graphical "output" with the Cartesian coordinate system, and many fascinating color projections as evidenced by the area of nonlinear dynamics and chaos theory. The Mandelbrot set is a good example, where if the equation generating the set is viewed as a program, the program's output can be visualized in many different ways, such as Figure 1.

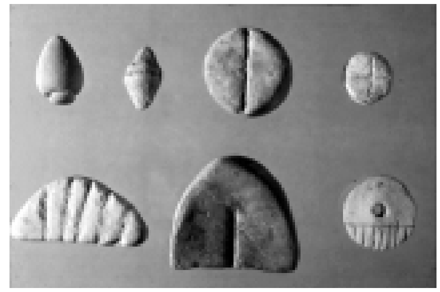


Figure 2: Clay tokens from Susa, Iran 3300 BC. Courtesy Musee du Louvre, Department des Antiques Orientales, Paris.

Areas within scientific visualization, and more recently information visualization [2] and software visualization [3] all contribute to bringing art into the computer and into the software which executes in the black box. With regard to dynamic systems in general, with software being one type of system, visualization also has a significant presence [4].

Based on the past research within computer science and systems science and engineering, it seems that all is well, and that we are on the road to a stronger bridge that has historically separated art and science. Generally speaking, this seems to be true; however, if we survey the landscape of aesthetics and styles afforded by art, we still find much of current day notations for both mathematics and software to be highly stylized and diagrammatic. For example, one may represent individual components and programs as primitives such as lines, circles, and rectangles or as Platonic-like solids such as spheres, pipes and cubes. Can we go further in our representations, and can we personalize mathematics, and its computer-science progeny to achieve a far richer aesthetic landscape?

Aesthetic Computing

Mathematical Beginnings

Aesthetic Computing is the study of artistic forms in the design of formal structures found in computing. The word "aesthetic" comes from the Greek *aisthetikos*, which means "sense perception." Our use of the word aesthetic is centered on pluralism, eclecticism, and hybridism, which is to say that aesthetic computing refers to the potential use of a large variety of possible styles. Therefore, aesthetic computing is defined with this variegated potential in mind. We can reverse the words “computer” and “art” and aesthetic computing becomes synonymous with “art computer” [5]. This area suggests the hypothesis that our notations for formal structures are largely dictated by the economics of labor; we notate in ways that are efficient given the current state of technology. At first, this may seem obvious, but it has dramatic consequences for envisaging new formal representations.

Tokens, as seen in Figure 2, and frequently found in clay envelopes in Babylonia, suggest that language of which mathematics is one kind, gradually evolved from small tokens and figurines into flatter, stylized text [6]. These tokens were used primarily for accounting, and expressed both mathematical quantity as well as the quality of sign-based representation. They represented our first non-oral language. For example, the token at the top right represents one sheep. A concomitant stylization of Chinese characters also demonstrates this evolutionary tendency away from certain artistic products toward more stylized, economically-motivated forms. To some extent, we sacrifice art, or at least its vast potential in form and style, for the sake of technology. This technology has delivered many fruits of knowledge and engineering, and so we are generally optimistic and cognizant of these trends toward changes in representation. Without these changes, we would not have computers, nor would we have computer art. We must recognize, though, that as technology evolves and the economy of labor shifts, so must our representations. If I am able to create a virtual sculpture in the same amount of time that I can type Y = X + 2, this is bound to have magnificent consequences on the potential for remaking certain formal notations in new artistic ways, and with additional dimensions such as sound, narrative, and tactile sensation.

Let’s start with a mathematical model and then progress to examples of dynamic models of systems and software. Consider the Mandelbrot set previously pictured in Figure 1. From a systems view, we are viewing the output of the equations used to generate and define the set. But the equations have remained in a black box of sorts. Yes, we might take the equations and express them with typographically and calligraphically aesthetic forms, but we might also use our newly acquired levels of technology to remake and remediate the equations. Equations, like other mathematical and computer forms, are expressed in ways convenient to our limitations in model representation. The equation for the Mandelbrot set is z = z2 + c. It represents a difference equation since z on the left side is the new value of z, and z on the right side is the old value. Difference equations rely upon iteration for their solution, by taking the new z and putting it back into the old z to, again, calculate another, newer, z. Variables z and c are in the complex plane and so can be manipulated as if they were (x,y) pairs, with the proper transformation. We begin with a value for c and then start z

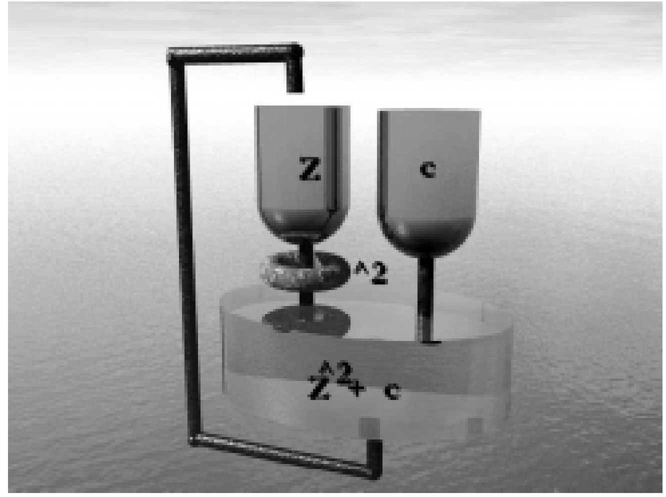


Figure 3: Mandelbrot Set machine

at zero, while continuing to iterate: 1) z = 0 + c = c; 2) z = c2+c and so forth. A pixel is colored black if z does not tend toward infinity (i.e., it is part of the set), and another color if it does. Different rates of divergence result in a spectrum of colors. If we shine our light inside the “equation box,” and use the pluralistic basis of aesthetic computing, we might instead remake the original equation using Figures 3 through 5.

Figure 3 shows a virtual “Mandelbrot machine” which has an isomorphic mapping to the original equation. Inside this figure, we have placed the equivalent variables, with the notation ^2 referring to the operation “to square.” Using a processing plant metaphor, quantities are placed into containers and the sum total is collected in the elliptical tub, whose resultant is then pumped back up into the original container for z. Figure 4 illustrates a monochromatic output from the machine.

New Focus and Goals

The goals of aesthetic computing build upon those of visualization as currently practiced in computer sci-

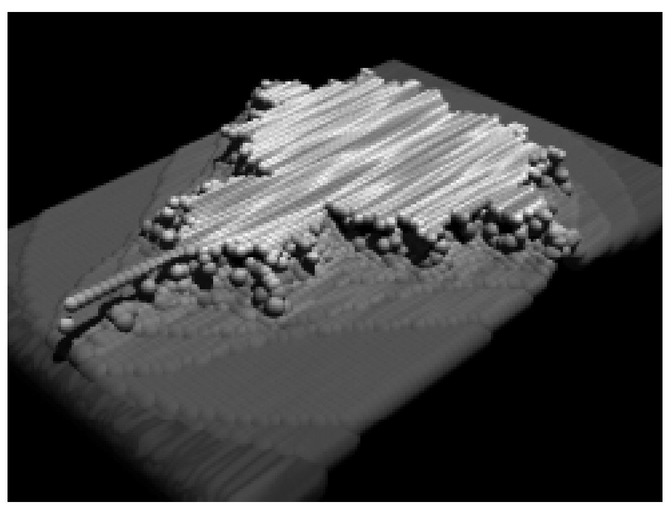


Figure 4: Resulting 3D Mandelbrot Set

ence, with a greater concentration on introducing aesthetic variety to traditional visualization projects. Cultural issues can predominate since, despite the evidence of an increasing rate of technology capability in creating virtual objects (through computer graphics) and physical objects (through rapid prototyping machines), computer scientists have been educated on more traditional fare, with textual notation having made its mark early in life. This is not to say that that computer science is averse to the idea of pluralistic aesthetics, but only that the field has grown upon a solid bedrock of mathematical notation. So, progressing toward greater freedom of expression does present a significant cultural challenge. The same goes for artists, on the other side of the coin, in that many artists are unfamiliar with formal model structures, even though they are well schooled in aesthetics. At the University of Florida, we have developed undergraduate and graduate degree programs in Digital Art and Science (DAS) and a Digital Worlds Institute [7] to help nurture students with a healthy blend of art and computer science.

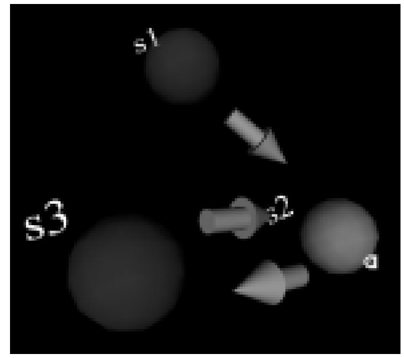


Figure 6: FSM using primitive solids

Abstraction

Abstraction has been heralded as the hallmark of mathematics and computer science, but it is important to isolate abstraction for its fundamental properties, which appear to often be confused with the material which goes into making signs. The concept of abstraction can surface as a reason not to employ more extravagant forms. However, abstraction cannot completely come to the rescue because the essence of abstraction is not so much a reduction in material used to represent a model, but rather in the use of one object to capture a subset of attributes for another; the actual structure of an object, minimal or otherwise, is unrelated to the object's abstraction role in modeling. The letters z and c in Figure 3 help us to connect the equation to the corresponding 3D objects, but they become excess baggage when considered in the larger view of what it means to be an equation. As with any language, meaning lies not in the object but in the relation among objects. Thus, the virtual machine in Figure 3 is equivalent, under isomorphism, to the equation text, and we may think of the vessels in Figure 3, designating variable names, as containing a fluid whose height, say, captures variable values. There is nothing about the very idea of "equation" that suggests that it must be represented by dried chemical inks and dead plant matter. A key difference in aesthetic computing, which differentiates it from prior efforts, is its focus on personalized, cultural representation rather than on standardized form. While standards may be created based on group aesthetics and convention, model design is construed to be a bottom-up activity that begins with a large diversity of styles and evolves not unlike its biological brethren. Usability, critical analysis as achieved through intermediary organizations (like a consumer's union for models), perceived needs, and market-driven demand will cull those designs and styles not meant to prosper in the large. The aesthetic computing field represents a call to a more diverse application of aesthetics for formal structure.

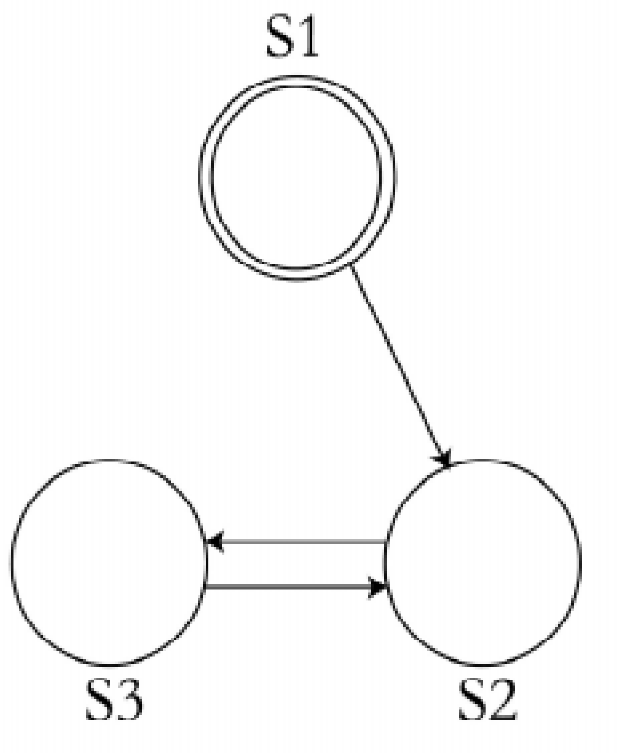


Figure 5: FSM in a 2D diagram

Virtual Analog

By selectively integrating artistic forms into mathematics and computing, in many ways we return to the past. The work in visualization is a return to a time when numerical information was visual and tactile, and a return to more calligraphically efficient, and expressive, forms of text realization. Knuth's TeX, for example, represents the return to gaining greater degrees of control over the text-based aesthetic as it was known and practiced before the introduction of typography and the printed book. This "boomerang effect" also shows itself in Figure 3 since prior to the electronic digital computer used today, we constructed analog computers whose components were far more visual and tactile then they are today. Figure 3 is a type of virtual analog technology, which borrows from the past but is remade for the future in a more efficient form.

Computing

What does all this have to do with software and computing? By beginning with mathematical notation and structure, we are in a position to extend these stylistic expressions to software [8], whose formal realization is

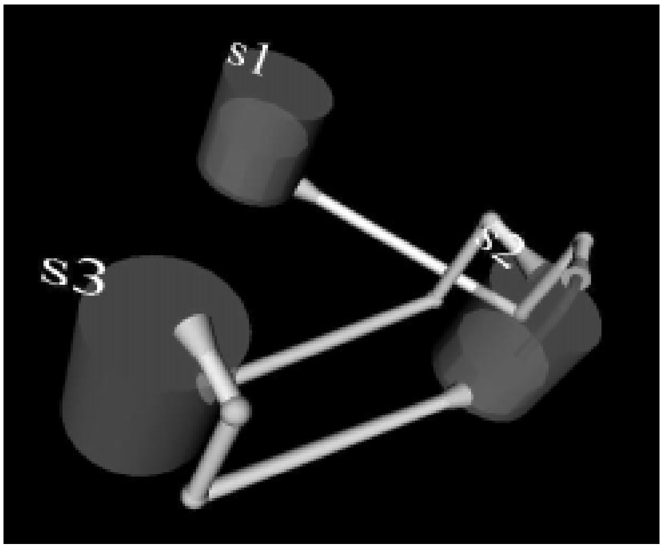


Figure 7: FSM using a fluid flow metaphor

mathematical. Creating software is a natural extension of creating mathematics. However, many developments in computer science allow us to construct abstractions onto the mathematical expressions, and these serve as useful metaphors for aesthetic application. For example, the object-oriented paradigm in software engineering serves as a guideline for creating artistic objects, and the agent-based paradigm serves equally as well for creating artistic agents. Each software paradigm indicates a way in which mathematical elements may be viewed, heard, or touched.

rube

rube is a software project begun two years ago in our research group. The primary purpose of rube is to facilitate aesthetic formal models. The package is currently tailor-made for model builders who have a scene graph, containing geometry elements, and want to combine this with a formal specification of a dynamic model. These two files are termed the scene and model files. Both files are expressed in the new lingua franca of the web, the extensible markup language (XML). XML turns out to be an ideal vehicle for personalization since it is designed around the idea of styles. Formerly termed style sheets, there are now more powerful style translation mechanisms (XSLT). The scene file serves in the same capacity as the skinz of customizable desktop interfaces and applications. Figures 3 through 5 are mathematical skinz.

The scene file is captured in the Extensible 3D (X3D) language, and the model file in the Multimodeling Exchange Language (MXL) being developed by our group. Both X3D and MXL have associated XML Schemas and are integrated, with Javascript and Java, to create a combined, interactive 3D environment.

Figure 5 displays the formal structure of a Finite State Machine (FSM) containing 3 states and 3 directed transitions, all triggered by a binary input of one. When zero is received by the FSM, the FSM stays in its current state, with S1 being the start state. Figures 5 through 8 display alternative aesthetics to the diagrammatic one in Figure 5, but the underlying MXL files are equivalent to that of Figure 5. Figure 6 displays primitive solids, not unlike fairly recent 3D programming language studies in the form of Najork's Cube language [9].

Figures 7 and 8 represent fluid flow and agent-based aesthetics. Figures 9(a) and 9(b) display a more complex program [10], a simple multi-tasking operating system, with programs being anthropomorphically presented as colored avatars, and OS resources being represented by people acting as servers behind desks. Different floor paths are defined to allow for avatars to queue behind each resource.

There are two different approaches to research on model structures for computing and mathematics: breadth-first and depth-first, to use a tree search analogy. In the depth-first approach, one specific presentation—an aesthetic—is chosen and studied in great detail for issues regarding its suitability for capturing all of the nuances of the formal semantics and robustness.

This approach is akin to the process of science, where the goal is to seek out uniformity and to perform analysis.

Our research is more along the lines of the breadth-first approach, where we do not single out one presentation style, but rather facilitate multiple styles, aesthetics,

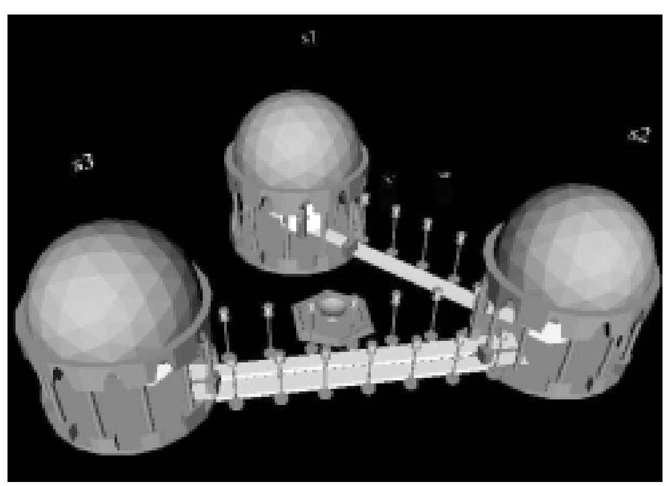
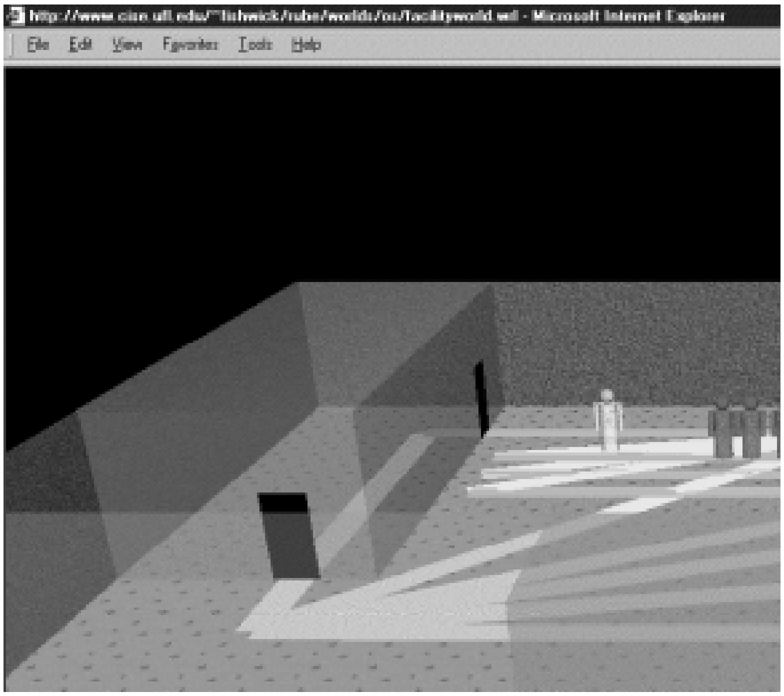


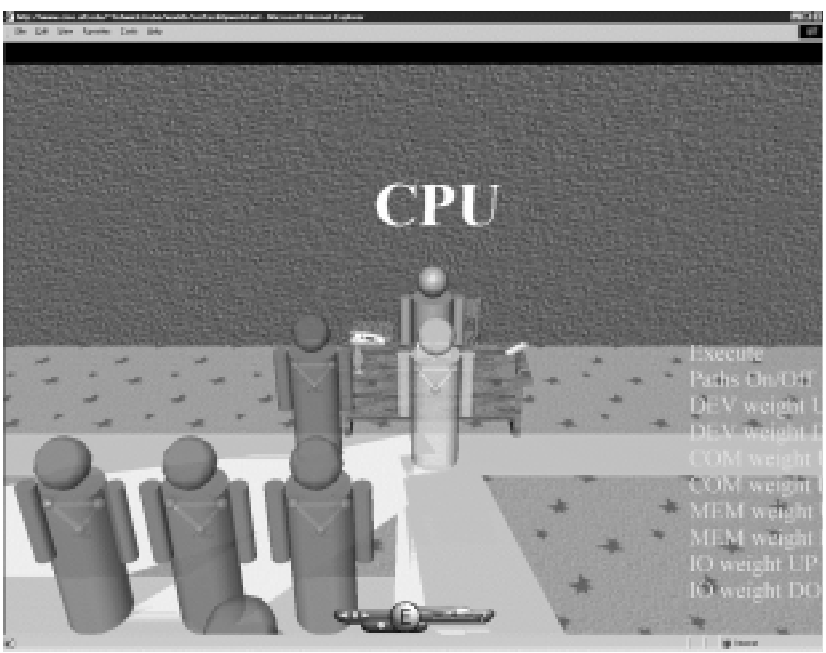
Figure 8: FSM using an agent metaphor

and personalized models via MXL. This approach is akin to engineering and art. This leads our work into other areas such as the ability of MXL to capture a broad range of styles. Clearly, there are likely to be many issues that plague 3D constructions in particular, most notably the layout problem (for semi-automated assistance in creating the scene) and the navigation problem (for being able to effectively peruse the model objects). Both the depth and breadth approaches are needed for aesthetic computing, if it is to progress.

Figure 9: Operating system architecture designed with an agent metaphor



(9a) Front View of complete floor



(9b) Close-up view of tasks awaiting CPU allocation

Summary

Aesthetic computing opens the doors for a highly interdisciplinary engagement of artistic forms, styles, and aesthetics for the re-presentation of formalisms. The style-based approach to XML, as the basis of the future World Wide Web, and the trend toward personalization and mass customization in marketing and manufacturing indicate that this interdisciplinary work is needed. We have recently begun research on a number of fronts to build rube: 1) including the use of sound and narrative to increase the flexibility of modeling, 2) surveying and testing students and faculty to obtain data sets for analysis to judge which issues are paramount in the area, and 3) working with artists, new media experts, and visualization researchers to flesh out remaining issues. Our plan is for rube is to develop MXL to where it can be widely employed for scientific and engineering model building, while directly supporting individualized and group-oriented perspectives and aesthetics.

Acknowledgments

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Loving the Logic of the Alien
by Aaron Wolf Baum, Ph.D.

How shall artists relate to computers? Many artists employ musical software, video and image manipulation software, internet technology, and many other software products. Others shun the use of computers, or protest the effect that they have on society. But computers are designed to be Turing machines—devices capable of executing any sort of logical instructions. In theory, the only limitations to what a computer can do are the number of computing cycles available and the connected peripherals. These limitations are expanding at fantastic rates, so any image of what computers are or can do cannot cover their true potential.

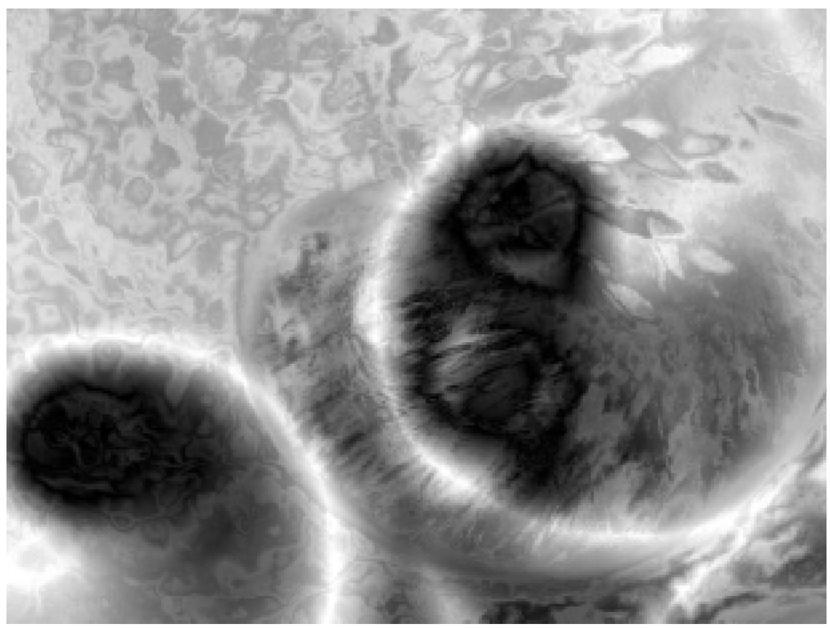


Figure 1: Aaron Wolf Baum, A frame from an algorithmic movie.

Most artists use existing software as their entry point to computer use. But all computer-based work created in this way carries with it the metaphors expressed in the software—generally control, editing, and automation—extensions of the industrial metaphors originally used to create the computer. These are the metaphors that have come to dominate our society. How delicious, then, to turn the universal power of computing toward the exploration of metaphors that explode such linear thinking?

I have always been attracted to metaphors in which something seems to come from nothing. The metaphor of the origin of life, how single-celled organisms emerged from non-living matter. The metaphor of multicellularity, how cells form a body. The metaphor of mind, how thought emerges from a mass of neurons. The metaphor of culture, the arts, sciences, customs and religions emerge from groups of humans.

When viewed from a mathematical standpoint, all of these systems have a common underlying structure. In each one a network of many simple units cooperatively create the system behavior. In living beings, genes interact through proteins. In the brain, neurons network through synapses. Ecosystems arise from webs of organism interaction. Culture results from the networks of human communication.

Can we use our mathematical understanding of these systems to explore the generalized aesthetic nature of this type of system? Can we use them to discover new forms of organicity, and of beauty? To explore the boundaries of the human sense of the beautiful, to find something of its essential nature, even to influence it—to learn to find beauty in the alien?

My installation work “Eternal Novelty Machine 1” (1998) creates a self-generating alien ecosystem of sound by networking together its own sound spectrum. Complex sound patterns arise spontaneously, bringing the listener a direct experience of the alien. The human aspect of the work is the design of the interconnections between past and future sounds through their sound spectra.

I have more recently been working on much tighter human-system feedback loops through motion capture gloves to interact with other self-organizing audio and video systems. With these gloves, all the nuances of gesture can be expressed and complemented by all the nuanced interdependencies of self-assembling systems. The self-assembling aspect of the system pushes the metaphor from that of player and instrument to one of collaboration. For example, my visual works create new frames at movie rates by digitally manipulating and combining previous frames. The recursion gives the output tremendous range and organicity; however, it makes it very complex to control. This is where the gloves come in, allowing the collaborator to span a vast range of space in the most intuitive way possible. The gloves prevent broken eye contact, and the mind quickly learns hand position; the learning is greatly accelerated by the immediate feedback. As the patterns evoke emotional and intellectual reactions, these influence the way the user moves the gloves, completing an aesthetic feedback loop that naturally starts to tell a human story—a journey through a strange universe which can be experienced by an audience at the same time. The human and the alien are brought together in creative symbiosis.

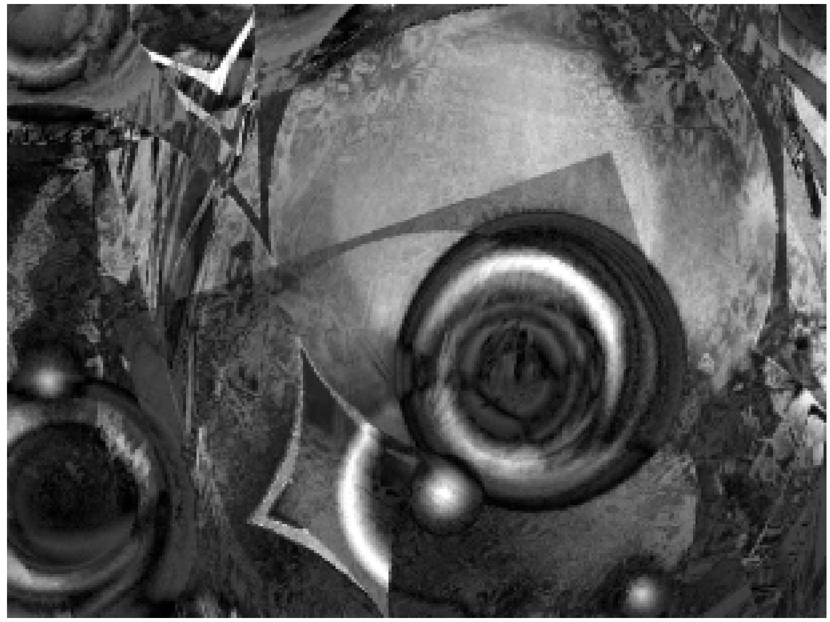


Figure 2: Aaron Wolf Baum, A frame from another algorithmic movie.

Most artists use existing software as their entry point to computer use. But all computer-based work created in this way carries with it the metaphors expressed in the software—generally control, editing, and automation... How delicious, then, to turn the universal power of computing toward the exploration of metaphors that explode such linear thinking?

Figures 1 and 2 show individual frames generated by the system. For more information, please visit www.drfriendly.com.

John Maeda

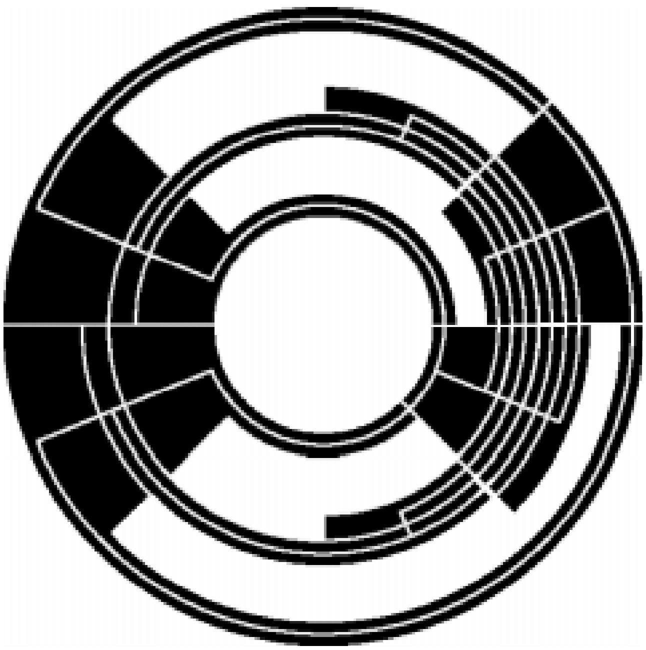
John Maeda is the Sony Career Development Professor of Media Arts and Sciences, Associate Professor of Design and Computation, Director of the MIT Media Laboratory Aesthetics & Computation Group (ACG) which works toward the design of advanced system architectures and thought processes to enable the creation of (as yet) unimaginable forms and spaces, and the principal of the Maedastudio (www.maedastudio.com/). His artwork can be found in his books “Maeda@ Media” and “Design by Numbers.”

John Maeda stated: Education is an important endeavor to pursue. First of all, it means that you have to study for a lifetime (otherwise your students can easily get ahead of you). Secondly, it means that you get to cheat your own eventual obsolescence by being an active part of the pool of evolving knowledge of a school. Third and most important, it means that you can pay back the lifelong debt to some teacher or mentor out there that gave you the spirit of hope when you needed it most. To me, education is the highest form of intellectual philanthropy.

Experimentation is also an important endeavor to pursue. You can be an experimental educator, of course, but you should also be an avid experimentor in your own work. Experiments can take the form of something exotic, but they do not necessarily have to be of an outlandish nature. Often the most obvious experiment is the most difficult to perform. I believe that students have the luxury of doing daily experimentation. I try to make it clear how great a privilege students have. I regret that some do not understand until only after their time runs out.

Robert J. Krawczyk
(www.iit.edu/~krawczyk)

Robert J. Krawczyk of the College of Architecture at the Illinois Institute of Technology in Chicago investigates the rules for creating geometrical patterns with possible applications for architectural design. To create a geometrical figure, Robert Krawczyk writes a mathematical program that describe a path generated by a moving point. This way he produces patterns that he calls spirolaterals where, for example, each successive line is one unit longer than the previous one. Thus, according to Robert Krawczyk, the rules for creating spirolaterals make it possible to generate artistic forms of unexpected complexity and beauty.



Robert J. Krawczyk

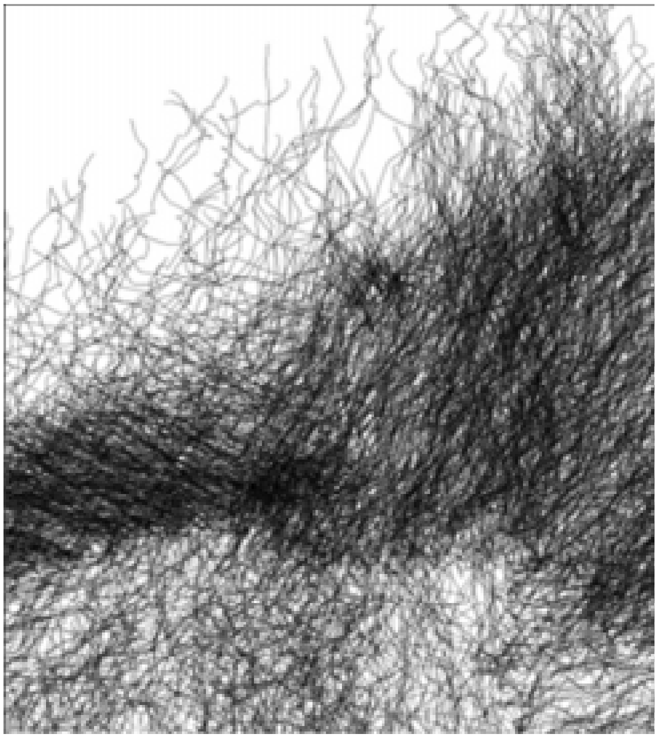
Robert J. Krawczyk

Hans Dehlinger

Hans Dehlinger wrote about his art:

Computer generated artwork, based on line-drawings, is challenging for a number of reasons. It makes use of lines as the characteristic element of the generative process, and the results rely entirely on the calligraphic qualities of the lines. Besides the heritage of hand drawings, which we conceive as a fantastically rich universe, we may conceive an equally fantastic universe of machine drawings. Line-drawings populating this universe should exhibit qualities in their own right like: exploit algorithmic techniques; be not reproducible by hand; show that they have been drawn by a machine; achieve a distinct and unique type of structuring; belong to an own identifiable universe; exhibit strong calligraphic qualities; make the question "how was it done?" entirely unimportant.

Lines are very simple geometric structures and at the same time inexhaustible rich elements of artistic expressions. This is one of the main reasons why I like to work with lines. From the vastness of possible structural descriptions of lines I have chosen the class of polygons and all my drawings are based on this type of line.



Hans Dehlinger, Walking in the Snow

I have chosen a personal definition, which makes these lines distinctly and in an identifiable way my lines. For the generation of such lines, relevant feature values are: number of starting points; number of lines originating from a given point; angular boundary for a polygon; spread of a segment; number of segments in a polygon. In statu nascendi, when a line is developing on a piece of paper, it does so from a unique starting point. It is the starting point, which calls for the first decision in a drawing process, no matter if the hand of an artist, or a computer driven device is steering the pen. The question of starting points and the question of the character of the line developing from those points have to be taken care of the programme. Especially interesting are two sets of algorithms, those, which generate drawings in a one-shot generative process, and those making use of composite processes.

When walking through a landscape in snow, we observe many types of linear structures. The tree as a metaphor and as an element of landscapes is a familiar image and a poetic reminder to enjoy life. What am I trying to communicate through my work? My interpretations of the mysteries and tragedies, that surround us.

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n. pronounced eylum, 1. a Greek word for the exploding mass from which the universe emerged.

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