Art and Code: The Aesthetic Legacy of Aldo Giorgini

Esteban García and David Whittinghill

ABSTRACT

In 1975 Aldo Giorgini developed a software program in FORTRAN called FIELDS, a numerical visual laboratory devoted entirely to art production. Working extensively as both artist and scientist, Giorgini was one of the first computer artists to combine software writing with early printing technologies, leaving an aesthetic legacy in the field of the digital arts. His individual process was innovative in that it consisted of producing pen-plotted drawings embellished by the artist's hand with painting, drawing, and screen-printing. This paper is the product of a multi-year study of Giorgini's primary source materials provided by his estate. The authors examine the methods used by Giorgini during the 1970s that allowed him to create computer-aided art, in the hope that publishing this work will ensure that future generations of digital artists, technologists and scientists can be educated in Giorgini's contribution to the history of the digital arts.

Esteban García
Artist and PhD Student
Computer Graphics Department
Purdue University
1204 Columbia Street
Lafayette, Indiana 47901
USA
garcia0@purdue.edu

David Whittinghill
Assistant Professor
Computer Graphics Department
Purdue University
Knoy Hall
401 N. Grant Street
West Lafayette, Indiana 47907
USA
davewhit@purdue.edu

Introduction

Aldo Giorgini (1934–1994) was a professor in the School of Civil Engineering at Purdue University. During the 1970s, he adopted the use of computers to visualize simulated terrains. His scientific visualizations as a civil engineer led him to pursue a creative artistic practice, which combined the use of mathematical models, computer graphics, and painting (Figure 1).

In 1975 Giorgini developed a software program called FIELDS, a numerical visual laboratory devoted entirely to art production. In FIELDS, FORTRAN instructions were loaded in a CalComp plotter and later printed on paper rolls. Giorgini incorporated handmade art techniques to fill in the lines printed by a CalComp 563 plotter. Some of these images were reproduced through an elaborate silk-screen printing process. His versatile technique combined high numerical computation with large-scale silk-screen printing. Working as both artist and scientist, Giorgini developed innovative techniques that left an aesthetic legacy in the field of digital arts. Giorgini was one of the first computer artists to combine software writing with early computer printing technologies to produce artistic images. His creative process consisted of the production of computer-aided images, which were embellished by the artist's hand with painting, drawing and screen-printing.

Figure 1. Aldo Giorgini installing his installation *Fiat Lux*. © 1980 Aldo Giorgini. Courtesy of Massimiliano Giorgini.

This research is the result of the analysis of primary sources found at Giorgini's residence in Lafayette, Indiana, and the Purdue University Archives and Special Collections. The sampled documents include manuscripts, letters, publications, clippings, printed code, cassette tapes, and CalComp prints related to the FIELDS project. This paper will unveil the methods used by Giorgini to produce his computer-aided art.

Artist and Scientist

Aldo Giorgini was born in Voghera, Italy, in 1934. He was influenced by Ambrogio Casati, an artist who was part of the Italian Futurist movement and who took Giorgini as an apprentice. As a young man in the 1950s, Giorgini helped Casati restore frescoes and oil paintings from the old masters that had been damaged during World War II.

Giorgini developed expertise in painting as a result of his work with Casati. This apprenticeship provided him with a solid groundwork in fine arts training. At age eighteen, Giorgini received a full scholarship to the University of Pavia where he finished his undergraduate studies in engineering. After this period, he commenced work on a doctorate in mechanical engineering, which he completed in 1959. Giorgini was an associate professor of hydraulics at the Polytechnic University of Torino from 1959 to 1961. Subsequently, Giorgini won a Fullbright Grant as an exchange scholar at the Colorado State University in Fort Collins. There, Giorgini completed a second doctorate in civil engineering in 1966. In 1967 he moved to West Lafayette, Indiana, to work as a professor in the School of Civil Engineering at Purdue University [1].

At Purdue's School of Civil Engineering, Giorgini experimented with software production and pen-plotter printers. From 1967 to 1976, he developed an interest in the visualization of numerical data in a graphic form. While a professor of civil engineering, he completed a third doctorate in Physics. Most importantly for this paper, Giorgini developed an extensive body of work as a computer artist from 1974 until his death in 1994. His artistic practice was not limited to art production, but included participation in early computer art exhibitions, publications, symposiums, and conferences. Giorgini was an advocate for this new field in the arts and he organized two symposiums: "Computers and the Design Process" in 1974, and "Computer Art" in 1975 [2].

Art with Computers

The use of the computer as a tool for artistic experimentation dates back to the first programmable computers. The Z3 computer built by Konrad Zuse in 1941 is considered the first binary, electromechanical, programmable computer. In a recent paper, Andrés Burbano explains Zuse's double role as scientist and artist: "While his work includes the creation of the first programming language, the *Plankalkül*, he was also an active visual artist for most of his life, and he himself defined his approach to the world as highly visual" [3].

Another example of early computer art is the work of Charles Csuri, who was a professor at Ohio State University and is known for his early experiments in the field of computer graphics. Csuri began exploring digital art in 1964, inspired by a computer-generated image he saw in a publication from Ohio State University's Department of Electrical Engineering [4].

Csuri used visualization software to produce the first computer-aided film in 1965. Like Csuri, Aldo Giorgini incorporated the use of computers in his artistic practice. However, Csuri's and Giorgini's approaches to computer graphics were fundamentally different. In the case of Csuri, the artist was not required to have the knowledge of the numbers and codes which produced the desired form. It was through the GUI that the digital image was produced. In the words of Csuri: "Additional software capabilities provide the user with the ability to modify system parameters through interactive devices and to alter curvilinear relationships without ever having to think of numbers" [5].

In contrast, Giorgini argued that a user who plays with a program by changing the value of the parameters at random is hardly intentionally producing the drawing. Giorgini used the term "canned program" to describe software in which a "pleasant" drawing could be produced without the intention of the user. Furthermore, Giorgini defined "intentional computer art" as only achieved when the user acknowledges all of the parameters of the program. According to his definition, if the user understands the mechanism of the program and what all of its parameters mean, it might be assumed the result was intentional [6]. Giorgini explained that art is defined by the intentionality of the artist. This allowed him to include software writing as part of his creative process. He gave priority to the artist's ideas over the tools [7].

Ideas as Art

Giorgini questioned the role of the artist as merely a producer of images. In his writings, he illustrates that the artist is the "ideator" of the drawing, and that several intermediate steps lay between the idea and the final product. In his own words, he explains the relationship between software and artist:

> The program is more than a medium: It is a "programme" with built-in directions which, no matter how open, still compel the artist to move with some constraints or on along [sic] some perspective, that are part of the original idea of the program. [8]

Visual artists from the 1960s shared similar thoughts about art, idea, and process. Emphasis on the work of art as an idea was a common characteristic of conceptual art in the 1960s. During this period, many artists explored the aesthetics of programmatic thought and execution. Reas, McWilliams, and Barendse explain how artists and musicians of this era created a different type of work that included writing instructions as a form of art [9].

Sol LeWitt's work is reminiscent of this program-natured visual art. In his writing entitled *{Software} Structures*, Casey Reas argues that LeWitt's instructions for his wall drawings can be compared to computer code [10]. For his wall drawings, LeWitt wrote a set of instructions for draftpersons who produced the physical piece. For example, the instructions for *Wall Drawing #366* read as follows: "Black arcs using the height of the wall as a radius, and black arcs using the midpoints of the wall as radius. The arcs are filled in solid and drawn in india ink" [11].

Although it is unknown how aware Giorgini was of the conceptual art tendencies of the 1960s, he certainly was interested in programmatic explorations in the visual arts. At the Computer Art conference entitled "Computer Art" held at Purdue University in 1975, Charles and Colette Bangert, Richard Helmick, George Chaikin, and Giorgini discussed computational aesthetics. As heard on the audio tape recording from this event, the works of Mondrian were described as compositional programs. According to Charles Bangert, Mondrian's use of the golden section to produce a composition is comparable to the algorithms used in computer art [12].

The computer-aided art pieces of Giorgini provide evidence of his unique array of talents. While at first glance writing software and art making did not seem to have a relationship, a few artists of that time, such as Giorgini and Csuri, sought to explore the aesthetic possibilities of new technologies. In Giorgini's words, "Each output device has its own graphical characteristics which, once fully understood and fully exploited, may yield an incredible amount of possible forms" [13].

In this section we described the context in which Giorgini produced his computer-aided art and how he theorized about the role of software in artistic practice. Giorgini's approach to aesthetics consists of the artist's intentionality and ideas to produce the artwork. Giorgini's focus on the "idea" as the most important value for the definition of visual forms connected his art to the conceptual art tendencies of the 1960s. His ideas in programmable aesthetics resulted in FIELDS, a program intentioned for artistic production. Giorgini established a conceptual separation between tools and ideas, giving more importance to the ideas.

FIELDS: A Numerical Visual Laboratory

In a report published by Purdue's School of Civil Engineering entitled "Interfaces", Giorgini defined FIELDS as a numerical visual laboratory. The use of the words "numerical visual laboratory" reflects Giorgini's approach to the production of images by changing parameters of the program. These numerical parameters were not just variables of a mathematical equation, they were the ingredients to produce lines, points, and ellipses. Giorgini explains the relationship between geometry, form and experimentation:

> Families of lines have a strong appeal to the imagination of anybody with [sic] inclination to geometrization. The gradual variation of curvature along each line from the other lines, constitutes an infinite source of aesthetic possibilities for exploitation. [14]

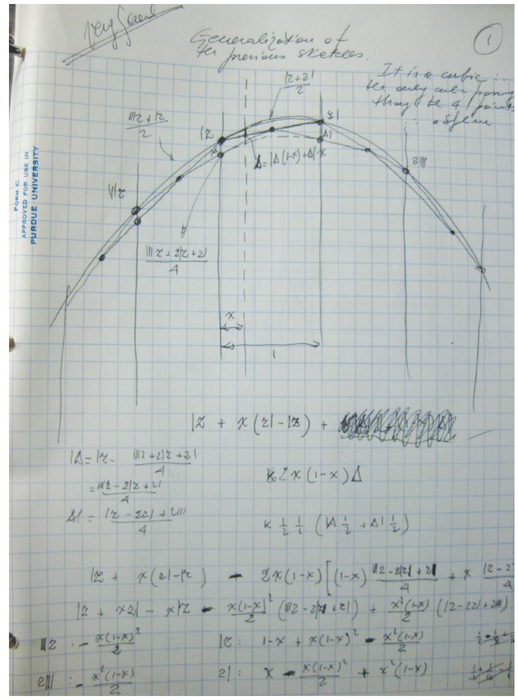

Figure 2. Manuscript. © 1974 Aldo Giorgini.

Giorgini's ability to visualize forms from mathematical functions allowed him to create lines and shapes from numerical values. Several manuscripts found in the Giorgini residence present evidence of his mathematical approach to graphics (Figure 2).

Visualizing the Z Dimension: A Mathematical Model

Giorgini's background in civil engineering and physics allowed him to use equipotential lines to produce contour lines. His research, particularly in terrain visualization while at Purdue, greatly influenced the aesthetics of his work. The computer-aided visual research from the civil engineering work awoke Giorgini's interest in aesthetics. Giorgini explains: "I started 'playing around' with some of the computer drawings that were made as illustration of the research done. From here to the purposeful use of the computer as an art tool the pace was very short" [15].

Some of the parameters of FIELDS are formulated in topographic terms. A piece produced by FIELDS can be described as a map view of mountains and valleys. A topographical representation in these two dimensions suggests a third dimension through the use of successive contour lines, which wrap around the different heights. In FIELDS, the fictitious value of depth was named Z, a highly three-dimensional concept.

FIELDS simulated physical fields by producing a gradiation of lines between surfaces of differing depth. The surfaces in FIELDS were named "boundaries" and they could be defined as points, ellipses, or circles. The program would create a field simulation that produced a series of contours around the "tallest" boundary towards the "lowest." The value of Z at the boundaries was 0 or 1. The contour lines were produced as a transition from these two values. In the words of Giorgini, "…the end product of the operations performed on the elementary potential surfaces will closely resemble the geometrical representation of a physical field" [16].

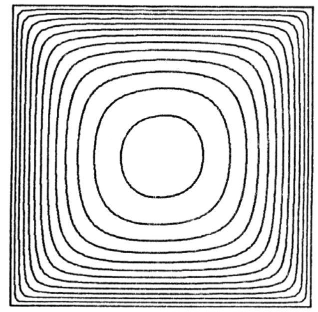

Figure 3. Top view of simulated fields. From Giorgini and Chen [6]. © 1974 Aldo Giorgini.

The result was an image that represented the top view of simulated fields (Figures 3 and 4). The composition was defined by sets of points in Cartesian coordinates to produce geometric shapes. These shapes were considered to be at Z=1 and would gradually transition to the boundary at Z=0, producing the effect of the rippled contours. In FIELDS, the boundary at Z=0 was typically a square that defined the aspect and border of the piece.

Giorgini was aware of technological advances for scientific visualization and had access to them through his laboratory at Purdue. His lab had a CalComp pen plotter, an instrument which draws lines on paper at the execution of a computer code. Giorgini envisioned the creative potential of CalComp as a new medium for art production. His strong background in mathematical concepts allowed him to formulate the visualization of numerical models.

In 1974, Aldo Giorgini asked his colleague at Purdue, Wei-Chung Chen, for assistance in developing a FORTRAN code of his mathematical model. This software was presented in the report entitled "Interfaces," containing 884 lines of code over 14 pages. The implementation of the mathematical model into FORTRAN code and its further interface with CalComp is the essence of Giorgini's numerical visual laboratory. Originally, the CalComp pen-plotter in his lab was used to create visual simulations of terrain. Giorgini used mathematical models to visualize real geographical topography.

Later, he used this technology to make large-scale artworks with a topographical aesthetic. In FIELDS, the piece is algorithmically produced from initial numerical values and printed in paper at run time. The numerical values defined the geometric boundaries of the initial shapes and the relationships between the different fields (Figures 5 and 6). A CalComp 563 plotter was loaded with bond paper rolls and drew the contour lines in black ink. The standard width of the available paper rolls for CalComp 563 was fifteen inches. However, Giorgini created the large-scale art pieces by printing in separated modules and mounting them together. Examples of his use of modularity in large-scale artwork can be appreciated in *Fiat Lux* and *Sculptural Forms*, found at the Potter Engineering Center at Purdue. His studio in the basement of his former residence holds hundreds of CalComp prints. It is important to remark that the prints themselves are not the work of art, because it was through Giorgini's process that these prints became art.

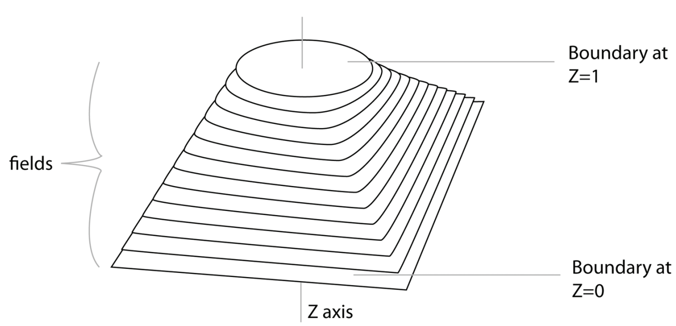

Figure 4. 3D representation of Figure 3, rendered by the authors. © 2011 Esteban García.

Code and Ink

After printing on paper, Giorgini started an elaborate handmade process for the completion of the art piece. He was interested in complementing the computer work with paint. In "Interfaces" he explains: "In the case where the output needs further intervention by the artist in order to produce the final art piece, the term of computer-aided art will apply" [17].

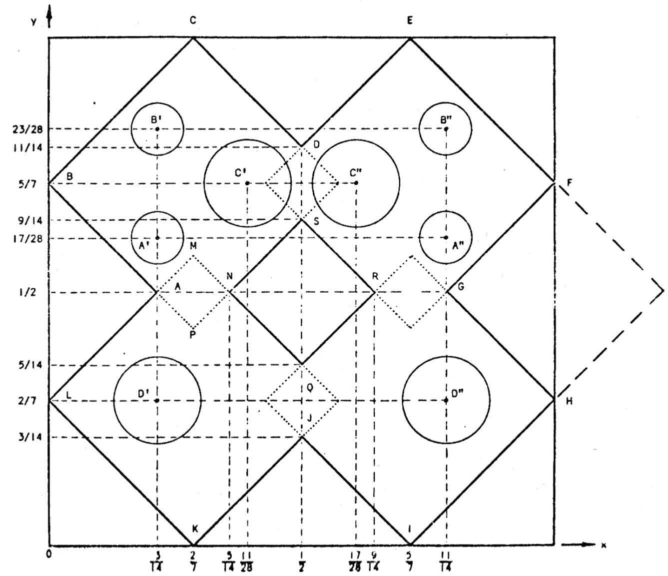

Figure 5. Geometric formulation of *Claustrophobia*. From Giorgini and Chen [6].

CalComp could produce only lines and Giorgini chose to fill in the shapes formed by the line intersections with checkerboard patterns. These often produced optical illusions such as Moiré patterns. One of the defining characteristics of Giorgini's works with FIELDS is that he only used black acrylic paints or inks to create these patterns. In the appendix of "Interfaces", he explains the perceptual visual qualities of Moiré and checkerboard patterns, however he does not explain the reasons for choosing these patterns. The work is reminiscent of Op Art, such as the work of Victor Vasarelly and René Parola, and it can be surmised that Giorgini had an interest in these artists.

Giorgini used high contrast reproductions of his work to produce the negatives for a silk-screen printing process. Silk-screen printing uses photographic emulsions and negative images printed on transparency paper to produce a template for image reproduction. Many of these silk-screen frames and negatives remain at Giorgini's former residence in Lafayette, where his son Massimiliano Adelmo now lives. In an interview, Massimiliano recalled that it took his father a "great deal" of time to master the silk-screening technique for the large-format prints he produced in his studio. Aldo Giorgini also experimented with inks of different colors, but he remained interested in high-contrast color combinations [18].

Giorgini also liked to screenprint T-shirts and sweatshirts and often wore them to teach classes or gave them away to friends. Aldo Giorgini's charismatic and interdisciplinary personality led him to influence the lives of many friends and students. In a dedicated column for the *Maximum Rock and Roll* magazine, record producer Lawrence Livermore explains: "… I would like to tell you about one very special man, who, though I've only spent a few hours in his company, has illuminated my life in a way only a very tiny handful of people have been able to" [19].

Giorgini spent the rest of his days working as an artist and a scientist. Giorgini left an inspiring testimony to early computer-aided art practice, which constitutes an important landmark in the history of the digital arts.

Discussion and Future Work

In an effort to preserve the aesthetic legacy of Aldo Giorgini, it is important to consider solutions for the preservation of his FIELDS software. One such solution entails the digitization of the 884 lines of FORTRAN code and implementation in Xcode, a modern-day compiler. Many compilers can read FORTRAN code through the installation of the widely available gfortran library.

In the future, we seek to explore a fully functional code that reproduces the functionality of FIELDS by producing an output image. In "Interfaces," Giorgini precisely formulated a question of authorship in relation to software art, which still remains unanswered today: "A computer drawing might have been made by a person with a program formulated by another person and programmed by another person again. Who is the artist?" [20]

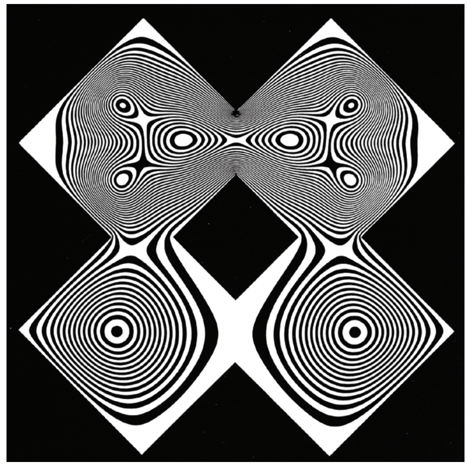

Figure 6. *Claustrophobia*. Acrylic and paint on paper, from "Interfaces" by Giorgini and Chen. From Giorgini and Chen [6]. © 1974 Aldo Giorgini.

In Giorgini's case, the work consists of these six steps: creating the software, defining the geometric boundaries of the composition, computation, printing, painting, and screen-printing. Giorgini used FIELDS to produce graphics which would be extremely difficult to calculate without the aid of a computer.

The preservation of Giorgini's FIELDS software in the form of a functional implementation in a contemporary system will allow future generations to revisit his innovative work. In recent years, there has been a rise of code-based toolkits for artists and designers, such as Processing, openFrameworks, Cinder, and Cing. Artistically oriented programmers have released a variety of software and libraries to allow artists to experiment in the realm of digital art. FIELDS constitutes a landmark in code-based art practices. The study of Giorgini's contribution presents a historical framework for artists who use programming as a medium.

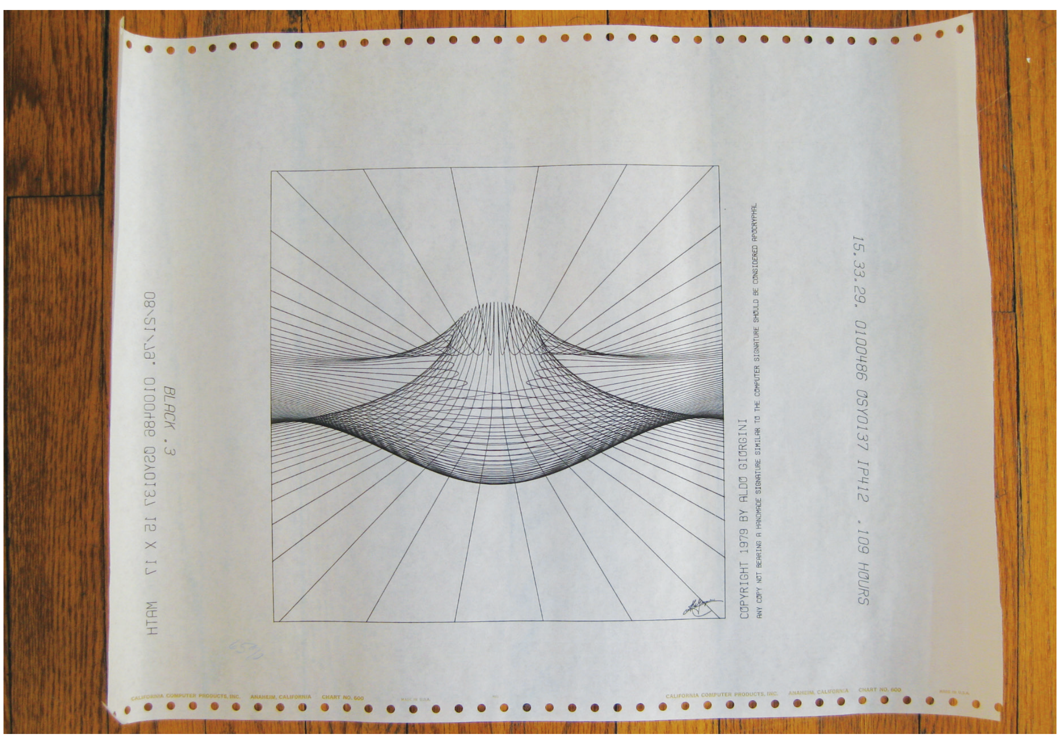

Figure 7. Example of one of Giorgini's CalComp prints. © 1979 Aldo Giorgini.

Conclusion

This research explains the importance of Aldo Giorgini's work in the field of the digital arts. The work of Aldo Giorgini is of historical significance because he adopted early computer technologies to produce computer-aided artworks. FIELDS constitutes an important precedent to software art. The documents found at the Giorgini's former residence in Lafayette possess historical value, and we consider the importance of the preservation of these materials for future generations. Preservation of these materials will capture some of the early methods and techniques used to produce digital art.

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