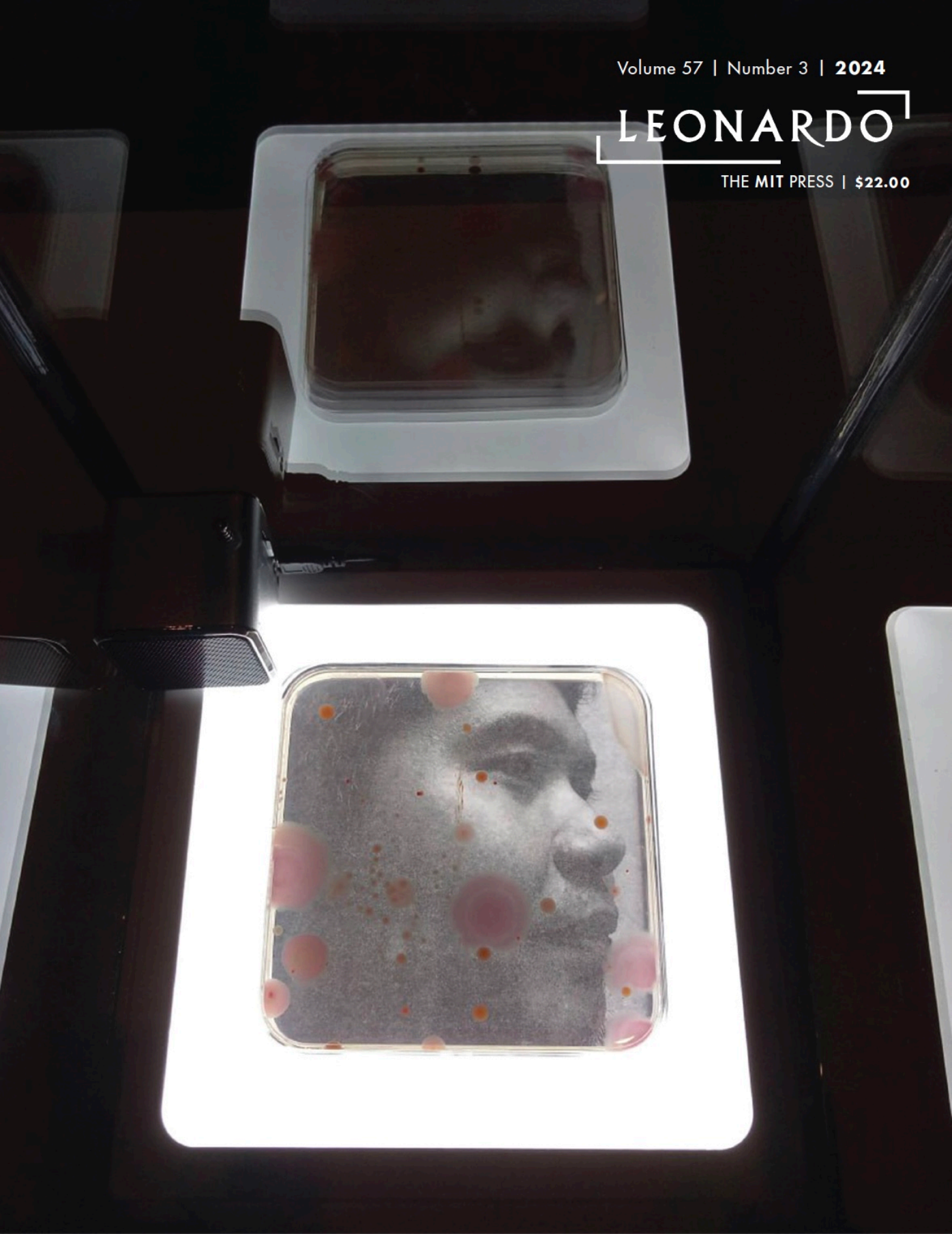
Volume 57 | Number 3 | **2024**

LEONARDO

THE **MIT** PRESS | **$22.00**



LEONARDO

Journal of the International Society for the Arts, Sciences and Technology

Volume 57 | Number 3 | 2024

ABOUT THE COVERS

Front cover: Amira Hanafi, *Another Us*, mixed media installation art, 2019. (© Amira Hanafi) See the article in this issue by Roslina Ismail, Amira Hanafi, and Kamaruzaman Jusoff.
Back Cover: Jack Tait, *Flame*, light image, 2020. (© Jack Tait) See the article in this issue by Jack Tait.

SUPPLEMENTAL FILES AVAILABLE

See https://direct.mit.edu/leon/issue/57/3 for supplemental files (e.g. video clips, sound files, additional images) related to articles in this issue.

Auro Lecci's Algorithmic Art

Toward the Computer as a Thinking Machine

PAOLA LAGONIGRO

ABSTRACT

This paper analyzes Italian artist Auro Lecci's contribution to pioneering media art, beginning with his paintings and ending with his computer artworks (1969–1972). As the author suggests, Lecci's paintings were already characterized by an algorithmic method that the artist went on to develop in his computer-generated works. The paper first discusses the plotter drawings Lecci created at the Computing Center of the University of Pisa (CNUCE), and then focuses on his last computer art project, made at the University of Massachusetts in Amherst, to suggest connections between Lecci's work and artificial intelligence.

Auro Lecci's experimentation with computers lasted just a few years, between 1969 and 1972, and it is still little known [1]. However, despite its short span, Lecci's work was exhibited and published in several well-known exhibitions and periodicals that are still considered fundamental in computer art history, as discussed later in this paper. Moreover, his last and most demanding computer art project deserves an in-depth reflection, since it was based on the idea of the computer as a thinking machine: an idea that still remains today. When seen within the context of Italian media art history, Lecci's work looks particularly relevant because between the 1960s and the 1970s there was no real computer art scene in Italy, despite the fact that several scholars were interested in art and technology [2]. This means that Lecci is definitely one of the first and few pioneers of digital art in Italy.

Starting at Lecci's work as a painter, this paper focuses firstly on its connections with the arte programmata movement to highlight a continuity with it, especially in its algorithmic method, which was to become central in Lecci's future computer-generated artworks. His experimentation with computers will then be discussed to observe what drove him to develop a project based on the idea of the computer as a thinking machine.

Paola Lagonigro (art historian), Sapienza Università di Roma, Dipartimento di Storia Antropologia Religione Arte Spettacolo (SARAS), piazzale Aldo Moro, 5, 00185 Rome, Italy. Email: paola.lagonigro@gmail.com. ORCID: 0000-0002-4916-6728.

See https://direct.mit.edu/leon/issue/57/3 for supplemental files associated with this issue.

AN ALGORITHMIC PROCEDURE: FROM ARTE PROGRAMMATA TO COMPUTER PROGRAMMING

Before experimenting in computer art, Lecci was a painter and had exhibited in several exhibitions since the mid-1960s. This distinction set him apart from many other computer artists of that time, who were engineers or mathematicians. As a Florentine artist, he participated in not only the city's contemporary visual art scene, but also its music, working with Pietro Grossi, one of the first Italian electronic musicians, and Italy's first electronic music professor at the Conservatory Luigi Cherubini of Florence. In the early 1960s, Grossi also founded the Studio di Fonologia Musicale—the second musical phonology studio in Italy after that of Milan—also known by its acronym, S 2F M [3]. The associated events organized by Grossi often involved visual arts [4] and Lecci was one of the Florentine artists who collaborated with the musician, designing the graphics for several conferences and public auditions, but also experimenting with electronic music. Indeed, at S 2F M Lecci had the opportunity to create some compositions for magnetic tape, which can be considered his first experiments with electronics, though still analog [5]. This season of experimental music was characterized by a strong dialogue with visual art: during the public auditions of electronic music, for example, the compositions were accompanied by visual representations [6].

A relevant example of this dialogue between music and visual art that can facilitate understanding of Lecci's artistic path is the *Ipotesi linguistiche intersoggettive* traveling exhibition, organized in 1967 by Centro Proposte [7], a center founded by art critic Lara-Vinca Masini in Florence, for which Lecci also designed the logo. In the exhibition catalog, Masini described the existence of a unique artistic area, a sort of "total aesthetic space" of figurative art, concrete poetry and electronic music [8], which actually corresponded to the three different spaces of the exhibition. In this period Lecci used to traverse the "total aesthetic space" described by Masini. In fact, at *Ipotesi linguistiche intersoggettive*, Lecci exhibited one of his paintings and an electronic music com-

 https://doi.org/10.1162/leon_a_02528

position for magnetic tape [9]. In this exhibition, Lecci's work was shown alongside that of many artists from arte programmata, whose research was already in its maturity in 1967 [10]. But while arte programmata was making way for new artistic tendencies, such as arte povera, the debate on the use of programming was still alive. In the Florentine exhibition, the electronic music section was curated by Grossi, who wrote about "programmed music" and "electronic calculators" [11], having just begun his journey into computer music.

Programming was a concept derived from computing and this meaning was embodied in the expression "arte programmata" in the 1962 exhibition [12]. Although none of the artworks was digital, the computer was a model [13], and the creative process of an artwork, based on the definition of a series of rules, could be described as an algorithm. Lecci's work comes precisely from this algorithmic and rational method. His paintings, like the one exhibited at *Ipotesi linguistiche intersoggettive*, were characterized by very precise linear structures based on geometrical studies (Color Plate C). Converging straight lines crossing geometric shapes—traced with a very meticulous technique—created optical effects that can be compared to the works by the arte programmata group Gruppo N. Despite the manual procedure, the minimalistic aesthetic of these paintings anticipated computer vector graphics.

Before discovering the computer as an art tool, Lecci also worked on recursive structures like *Strutturazione ricorrente n.19* (Fig. 1), a silkscreen that art critic Cesare Vivaldi referred to as "rigorous abstractionism" [14]. This geometric abstractionism reveals a calculated method and a precise design. Since an algorithm can be defined as a set of rules to be followed, we can identify an algorithmic method in such works, even though they were manually produced. Therefore, even before the use of the computer, Lecci's painting drew from methods and aesthetics that we now recognize as characteristic of the pioneering phase of computer art: algorithmic procedures and geometric shapes. Its roots are to be found in arte programmata, which had already taken the computer as a model.

Fig. 1. Auro Lecci, *Strutturazione ricorrente n.19*, silkscreen print on panel, 120 × 120 cm (© Auro Lecci).

But Lecci's painting lacked variability: the conception of the artwork as something that could assume a multitude of possible forms. This multiplicity of forms and perceptions was one of the key concepts in arte programmata that Umberto Eco defined as a dialectic between chance and program [15]. The refusal of a definitive work of art and the openness to chance is also in Eco's notion of the "opera aperta" [16] as well as in his *La forma del disordine* [17], an article published some months before the *Arte programmata* exhibition in *Almanacco Letterario Bompiani 1962*, which was dedicated to "electronic calculators." With the computer as an art tool, Lecci decided to take his creative process beyond the limits of a definitive work, attracted as he was by the possibility of delegating partial authorship of an image to a machine: an artwork could be encoded in a computer program with algorithms providing a series of rules and random choices.

PROGRAMMED RANDOMNESS FOR COMPUTER-GENERATED IMAGES

In the summer of 1968, Lecci visited the pivotal *Cybernetic Serendipity* exhibition in London [18] and was fascinated by artworks that were produced by balancing well-defined rules and chance, mathematical instructions and randomness. Some months later, in early 1969, he entered the Centro Nazionale Universitario di Calcolo Elettronico (CNUCE): the computing center of the University of Pisa, which was founded in 1965 thanks to an agreement with IBM [19]. This foundation confirmed the University of Pisa's leading role in computing, which started in the 1950s when it became home to the first Italian scientific computer [20]. In 1969, Lecci attended a programming course organized by Grossi, who had begun working on computer music at CNUCE. After learning the FORTRAN programming language, the artist wrote his first program: Slant [21].

As in other computer art pioneers' works, such as Michael Noll's or Frieder Nake's, the plotter drawings created by the program Slant are all different (Figs 2–3) because it includes a subroutine that provides random numbers. There are only two predetermined decisions: the slope of the lines and the distance between neighboring lines inside blocks. The program then has three decision levels, all taken at random: the first determines the length of the entire drawing along the X axis; the second the length of the lines along the Y axis and the number of lines needed to form a block; the third decision controls connections between blocks and decides on the length of jumps, if any [22].

If we compare *Slant* to Lecci's previous paintings, we can find many analogies: the same geometric abstractionism, the straight lines, which are so typical of vector graphics, and even similar contrast. The last point is actually the result of lithography, a technique Lecci was already familiar with as a graphic designer and one he used in order to switch the

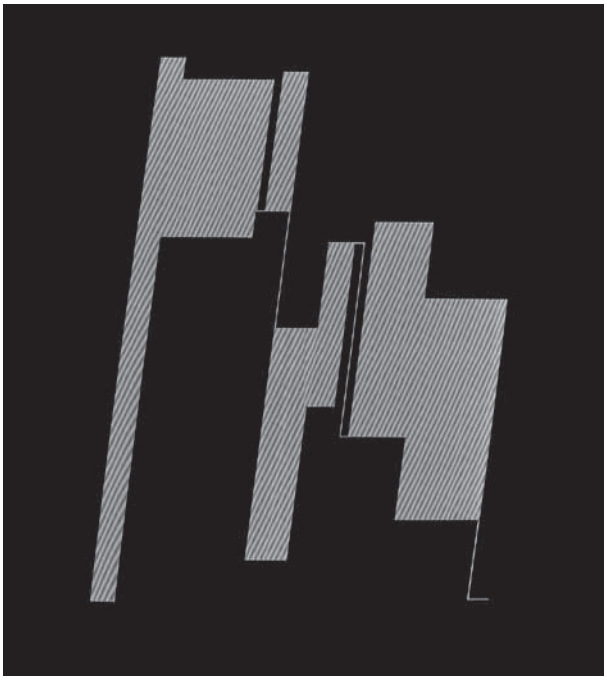


Fig. 2. Auro Lecci, *Slant One*, 1969, lithograph (from original plotter print), 46.8 × 42 cm (© Auro Lecci).

Fig. 3. Auro Lecci, *Slant Two*, 1969, lithograph (from original plotter print), 43.5 × 43.5 cm (© Auro Lecci).

colors of the original plotter drawings. He never exhibited the original prints because he found the plotted lines too delicate and thin (see the comparison in Fig. 4). This choice also suggests that Lecci was less interested in what the computer could materially produce than in the involvement of the machine in the creative process (i.e., a computer-generated design), and the possibility of experiencing an unexpected result every time the program was run.

Lecci's first computer artwork soon had an international resonance. In 1969 *Slant One* was published in the journal *Computers and Automation,* which, as early as 1963, had launched the first ever global computer art contest and published its choice of the best works every year [23]. The same work also had an honorable mention at *Fall Joint Computer Conference* in Los Angeles [24]. But, above all, immediately after their realization, *Slant One*, *Slant Two*, and *Slant Three* were exhibited in Zagreb, Croatia, at *Tendencije 4*, the fourth edition of the international movement Nove Tendencije (New Tendencies).

Since its beginning in the early 1960s, this movement was dominated by arte programmata and, more generally, by kinetic and optical art, which represented a response to informal art and abstract expressionism. Building on the lesson of Constructivism and Bauhaus, Nove Tendencije proposed a rational aesthetic and formulated an idea of "visual research" with a scientific base. An important shift occurred in 1968 when a biennial program, with exhibitions and conferences, was published under the title *Computers and Visual Research* [25]. Lecci was among the artists included in the 1969 exhibition, within the context of an international critical debate started the previous year with a colloquy [26] and the publication of a new magazine: *Bit International.* The first issue of this magazine focused on information aesthetics, with texts by Max Bense and Abraham Moles, who had independently (Bense in Germany, Moles in France) formulated their theories in the 1950s [27]. Deriving from Norbert Wiener's cybernetics and Claude Shannon's information theory, they suggested the possibility of measuring the aesthetic value of an artwork with scientific parameters. Information aesthetics is a theory with a scientific basis that influenced not only many artists among the pioneers of computer art [28] but also some Italian scholars such as Eco and Silvio Ceccato, a philosopher and among the first experts on cybernetics in Italy [29]. It is precisely in this theoretical framework of information aesthetics that we should approach Lecci's computer-generated works, as is also suggested by Nake, who recognizes Lecci among the first artists of algorithmic art, connecting them to information aesthetics [30].

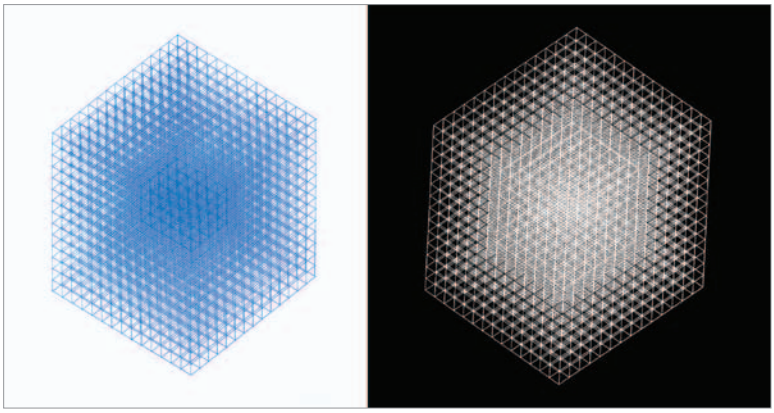


Fig. 4. Auro Lecci, *Lattice*, 1969. On the left, *Lattice 01* (plotter drawing), 43,5 × 45 cm, on the right, *Lattice 02* (lithograph), 45 × 45 cm (© Auro Lecci)

While Lecci's work was exhibited and published abroad in the context of computer art and within the theoretical frame of information aesthetics, Italy still seemed to be uninterested in computer art [31]. At the same time, arte programmata was making way for new art movements, such as arte povera, introduced by art critic Germano Celant in 1967. In Italy Lecci exhibited his first computer artworks together with the artists of Centro Ricerche Estetiche F1, a group Lecci founded in 1968 with Lanfranco Baldi, Paolo Masi, and Maurizio Nannucci, soon joined by Mauro Bassi, Massimo Nannucci, Vittorio Tolu, and Giancarlo Zen [32]. The group initially bonded over the same abstract language, but when Lecci started experimenting with computers, all the other members of the group created artworks that were very distant from the two-dimensional aesthetic of a plotter drawing. This distance is clear even from a quick look at the pamphlets accompanying the exhibitions *Latitudine/Longitudine* (1969) [33] at Marciana, where Lecci exhibited *Slant*, and *Ventunoundicisessantanove* (1969) [34] at Galleria Il Diagramma in Milan, where the artist showed his second computer artwork: *Lattice* (Fig. 4). Always playing on the balance between rules and randomness, in *Lattice* Lecci created an ambiguous geometric shape similar to a hexagon (a two-dimensional shape) as well as a cube (a three-dimensional shape). As in *Slant,* a subroutine of the program provides random numbers that change the point of view of the lattice, always creating a different drawing [35].

In Italy, amid a general lack of interest toward experimentation with computers, there was an important exception: the 1970 Venice Biennale. Curated by Umbro Apollonio and Dietrich Mahlow, *Ricerca e progettazione: proposte per una esposizione sperimentale* focused on the relationships between art, society, and technology, starting from Constructivism. Part of the exhibition was dedicated to computer art [36] —although in the catalog the expression was never used— and Lecci was the only Italian artist exhibiting with other computer art pioneers: Herbert W. Franke, Nake, Georg Nees, Philip Peterson, Richard C. Raymond, and the Japanese Computer Technique Group (CTG). Emphasizing the importance of the project over the object, the visual research over the unique artwork, this Biennale framed computer art in the context of a rational and technical art, with a social function, against the romantic idea of the "artist-genius" [37], proposing some ideas already discussed in Zagreb [38].

In Venice, Lecci showed *Shift 1* (Fig. 5) and *Shift 2*, two lithographs in which the artist combined several plotter drawings created with a new program: Shift. Unlike the previous projects, Shift shows the evolution of a shape when the focal point changes, which is why Lecci decided to combine more plotter drawings in a single print. The compositions exhibited in Venice both play on the variation of the focal point: each shift provokes a change in the density of the lines and therefore a three-dimensional effect. In 1970, *Shift* was exhibited in London, alongside *Slant* and *Lattice*, by the Computer Arts Society [39]. The same works were also exhibited at another event dedicated to computer art: *Generacion Automatica de Formas Plasticas*, organized by Ernesto Garcia Camarero at the Centro de Càlculo de la Universidad de Madrid [40]. One year later, while published by Franke in his book *Computer Graphics, Computer Art* [41], *Shift* was also shown in Vienna at the *Italianische Kunst Heute* exhibition, curated by Palma Bucarelli, director of the Galleria Nazionale d'Arte Moderna in Rome [42]. But, again, Lecci's work was not related to the impact of new technologies: the context was in fact a wide retrospective on Italian abstractionism that also included informal painting.

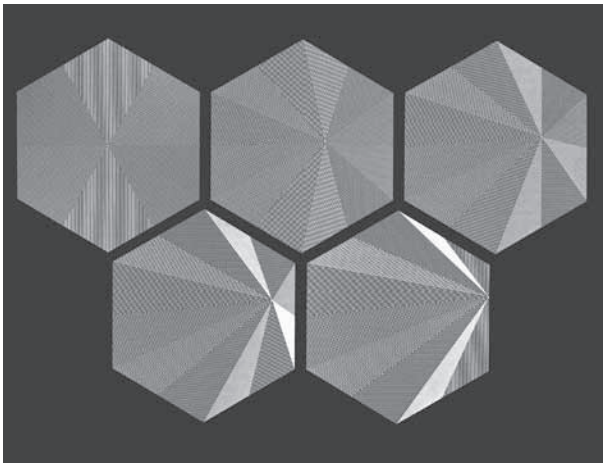


Fig. 5. Auro Lecci, *Shift 1*, 1970, lithograph, 92 × 68 cm (© Auro Lecci). For *Shift 1* Lecci combined different plotter drawings via lithography. In this way he showed the evolution of a shape.

To demonstrate the fact that Lecci evidently worked in isolation in Italy, we can consider the 1971 special issue of *Rivista IBM* which was dedicated to art, music, and poetry "in the age of technology." This issue contains an article by art critic Tommaso Trini that analyzes the relations between art and technology but makes no mention of any Italian artist [43]. Yet, in the same issue, *Shift 1* and *Shift 2* were published as illustrations of an article by Silvio Ceccato about aesthetic communication [44]. Given that Lecci couldn't obtain sufficient support for his research, he decided to leave Italy.

THE COMPUTER AS A THINKING MACHINE

In 1970 Lecci left Florence for the University of Massachusetts, Amherst, where another computer artist, Robert Mallary, was teaching. He studied at the Department of Computer and Information Science [45] where he attended an artificial intelligence course. As a result, between 1971 and 1972, he developed his last and most demanding computer artwork: *ArcLink* (Fig. 6) [46]. Lecci defined this work as a "syntax-based picture program": a program that generates pictures in accordance with the rules of a grammar. Distinct from Lecci's previous works, *ArcLink* generates pictures not just by a series of instructions and random options but by a particular syntax.

In 1973, *ArcLink 3 Phrase-Picture Marker*, which illustrates the generative process of a picture with *ArcLink* (Fig. 7), was published in the German book *Apparative Kunst* by Franke and Gottfried Jager [47], as well as in the *Tendencije 5* exhibition catalog [48], where *ArcLink* was exhibited. Both cases contain a long text written by Lecci that explains the operation of this syntax-based picture program. Artificial intelligence is never mentioned, but the artist emphasizes the construction of a grammar and the automatic generation of a picture.

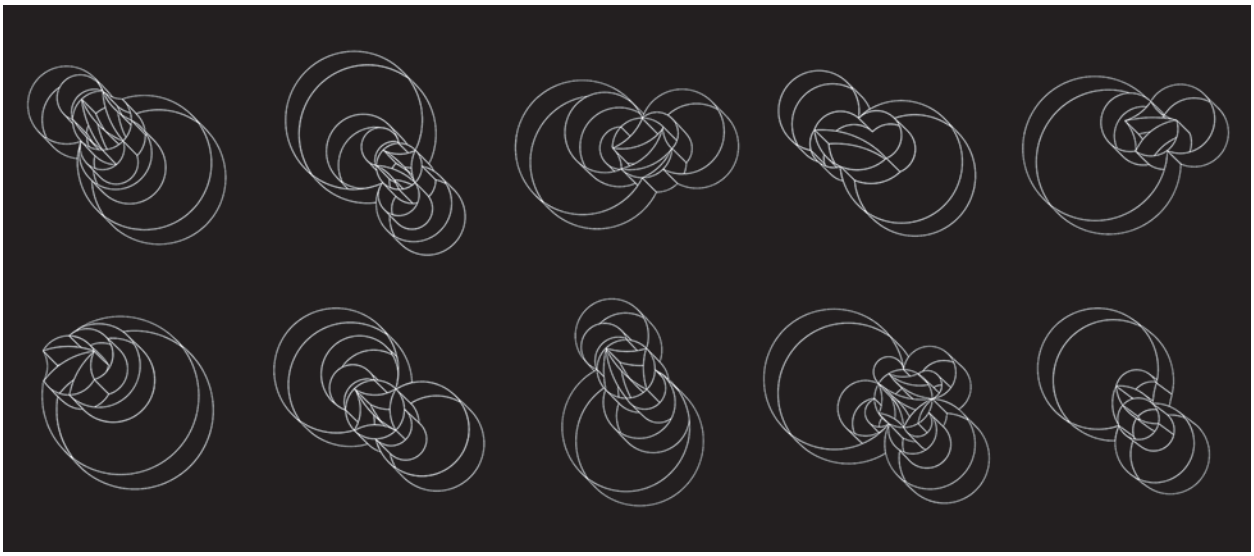
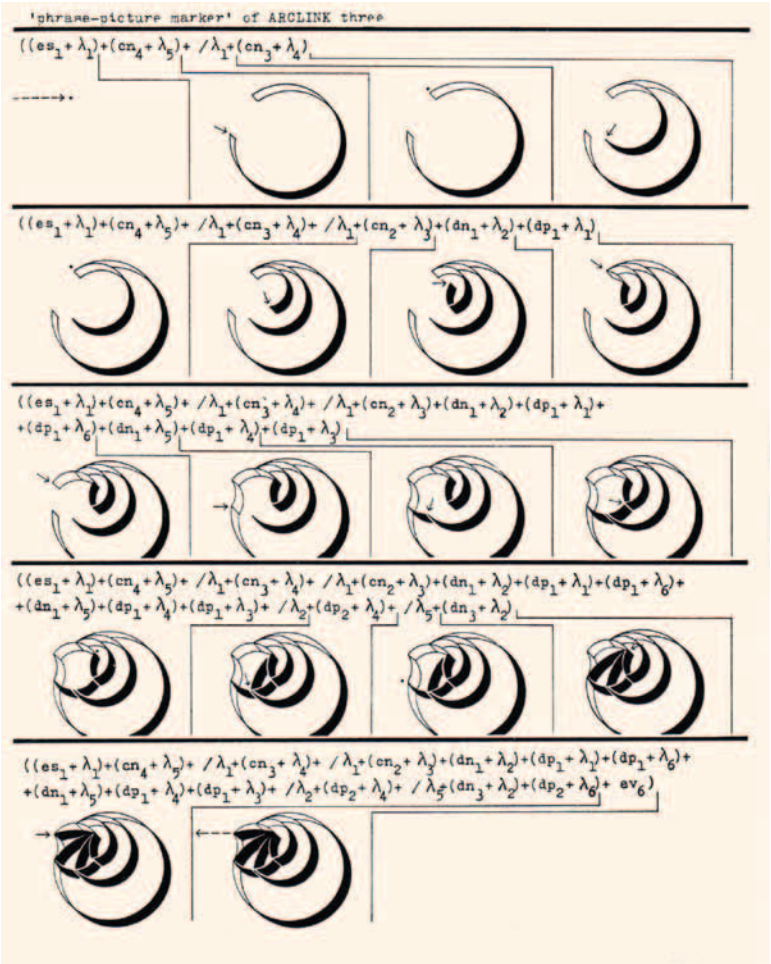


Fig. 6. Auro Lecci, *ArcLink 2*, 1972, photographs on two panels, each 74 × 24 cm (© Auro Lecci, Courtesy of the Anne and Michael Spalter Digital Art Collection). This work was exhibited at *Tendencije 5* (Zagreb, 1973).

According to this text, each picture of *ArcLink* shows a set of nodes distributed on a curve of constant radius. The nodes are connected by arcs in such a way as to preclude the intersection of arcs, as well as the repeated concatenation of the same two nodes. The picture is progressively developed to the point of total saturation of all available nodes. As in the previous projects, there is again a stochastic process, starting from the origin of the picture. The origin can be any suitable point in the picture plane, and each arc can then have a negative or a positive curvature, as well as a clockwise direction or a counterclockwise direction. All these graphic elements are defined by a grammar that Lecci created. The grammar generates a picture language, and this language generates an image.



Since the beginning of his research with computers, Lecci had been fascinated by the idea of creating an image with the help of the machine. The serendipity celebrated in the *Cybernetic Serendipity* exhibition, the happy chance discovery, also referred to the use of stochastic processes that let the computer create something unexpected. In *ArcLink* this idea was emphasized because the computer was not just a drawing machine, but was considered by the artist as a thinking machine, able to "speak" a language.

Unfortunately, Lecci didn't update *ArcLink* after 1972. In fact, while *Tendencije 5* revealed the emergence of contemporary conceptual art, by 1973 Lecci had already moved back to Italy and abandoned what was once called computer art, feeling that this field of experimentation was dominated more by scientists than by artists [49].

Considering the widespread use of text-to-image software, we should recognize the relevance of a work such as *ArcLink*: a work in which an image was generated by a language, although not a natural one but a formal, mathematical lan-

Fig. 7. Auro Lecci, *ArcLink 3 Phrase-Picture Marker*, published in Herbert W. Franke and Gottfried Jager, eds, *Apparative Kunst. Vom Kaleidoskop zum Computer*, 1973. This is the generative process of a picture with *ArcLink*, from the first arc (a curve of constant radius) to the total saturation of all available nodes.

guage, with specific rules defined by the artist. Although *ArcLink* was never presented as an artificial intelligence project, it clearly stemmed from that research field, despite it being of marginal interest in the early 1970s computer art scene. In conclusion, Lecci's greatest contribution to the field of pioneering media art is to be found, arguably, in his attempt to combine the "programmed randomness" of early computer art with the artificial intelligence research of the time.

Acknowledgments

The author would like to acknowledge Silvia Bordini and Francesca Gallo for reading the first draft of this paper and offering advice and Irene Caravita for encouraging this research.

References and Notes

1 Among the scholars who have written more recently about Lecci, Grant D. Taylor should be mentioned though he has recognized Lecci's work more for its "constructivist machine aesthetic" than for its algorithmic nature. See Grant D. Taylor, *When the Machine Made Art: The Troubled History of Computer Art* (New York: Bloomsbury Academic, 2014). It should also be mentioned that the Victoria & Albert Museum acquired a significant corpus of works by Auro Lecci in 2015.

2 The interest in art and technology was particularly related to leftist ideology: see Giovanni Rubino, "Art, Technique and Ideology: Between Italian and Croation New Tendencies," in *CroArtScia. Symmetry: Art & Science* (Zagreb, 2011) pp. 155–160.

3 Francesco Giomi, "The Work of Italian Artist Pietro Grossi. From Early Electronic Music to Computer Art," *Leonardo* **28**, No. 1, 35–39 (1995).

4 For instance, two evenings of Vita Musicale Contemporanea were dedicated to projections of the films *Arte programmata* and *I colori della luce* by Studio Monte Olimpino (Bruno Munari and Marcello Piccardo) and music by Luciano Berio: see Girolamo De Simone, *Pietro Grossi: il dito nella marmellata* (Florence: Nardini, 2005).

5 *6 Audizioni di musica elettronica*, Conservatorio di Musica Luigi Cherubini, 1966, flyer, Auro Lecci's Private Archive, Firenze (below, AAL); *Musica ex Machina*, Museo di Storia Naturale di Verona, 1968, flyer, AAL.

6 Examples of these visual representations are published in the *Ipotesi linguistiche intersoggettive* exhibition catalog: Giulio Carlo Argan et al., *Ipotesi linguistiche intersoggettive* (Florence: Centro Proposte, 1967).

7 The exhibition inaugurated at Libreria Feltrinelli in Florence and then moved to Bologna, Lecce, Livorno, Naples, Sansepolcro e Turin. See Argan and et al. [6].

8 Lara Vinca Masini, in Argan et al. [6], n.p.

9 *T 10/0,5* is an electronic music composition in which the duration of the frequencies is between 10 cm and 0,5 cm of magnetic tape.

10 The expression "arte programmata" was coined already in 1962 at a well-known exhibition organized by Bruno Munari and Giorgio Soavi at Olivetti showroom in Milan. In the catalog the essay was written by Umberto Eco: see Bruno Munari and Giorgio Soavi, eds., *Arte Programmata. Arte cinetica, opere moltiplicate, opera aperta* (Milano: Officina d'Arte Grafica Lucini, 1962).

11 Pietro Grossi, "Il calcolatore elettronico," in Argan et al. [6], n.p.

12 On the notion of "programming," see also Margit Rosen, "The Art of Programming. The New Tendencies and the Arrival of the Computer as a Means of Artistic Research," in Rosen et al., eds., *A Little Known Story about a Movement, a Magazine and the Computer's Arrival in Art: New Tendencies and Bit International, 1961–1973* (Karlsruhe: ZKM/Center for Art and Media; Cambridge, MA: MIT Press, 2011), pp. 27–42.

13 Lindsay Caplan, *Arte Programmata: Freedom, Control, and the Computer in 1960s Italy* (Minneapolis: University of Minnesota Press, 2022); Lindsay Caplan, "Model, Metaphor, Analogy: The Computational Imaginary in Arte Programmata's Experimental Environments, 1964–68," *piano b. Arti e culture visive* **7**, No. 2, 22–44 (2022).

14 Cesare Vivaldi, "Quattro presenze a Revort 2," *Collage*, No. 8, 80–85 (1968).

15 Umberto Eco, in Munari and Soavi [10], n.p. The English translation of Eco's text has been published in Rosen et al. [12] pp. 98–101.

16 Umberto Eco, *Opera aperta: forma e indeterminazione nelle poetiche contemporanee* (Milano: Bompiani, 1962).

17 Umberto Eco, "La forma del disordine," in *Almanacco letterario Bompiani 1962* (Milan: Bompiani, 1961) pp. 175–188.

18 Jasia Reichardt, ed., *Cybernetic Serendipity: the Computer and the Arts* (London: Studio International, 1968).

19 Giuseppe De Marco, Giovanni Mainetto, and Riccardo Medves, "Il CNUCE tra i primi centri di calcolo in Italia," *Rivista di informatica* **XXX**, No. 3, 163–181 (2000).

20 Corrado Bonfanti, "L'industria del computer in Italia. Appunti per una storia," in *L'informatica: lo sviluppo economico, tecnologico e scientifico in Italia* (Florence: Edifir, 2007) pp. 53–61.

21 The program was written on an IBM 026 keypunch machine for a mainframe IBM 7090.

22 *Tendencije 4* (Zagreb: Galerija Suvremene Umjetnosti, 1970) n.p.

23 The first prize went to Tom Childs, while Lecci was one of the 28 artists to have their work published as an honorable mention. See "7th Annual Computer Art Contest," *Computers and Automation* **18**, No. 9, 12–32 (1969).

24 *Fall Joint Computer Conference*, 1969, flyer, AAL.

25 Rosen et al. [12] and Armin Medosch, *New Tendencies: Art at the Threshold of the Information Revolution (1961–1978)* (Cambridge, MA: MIT Press, 2016).

26 In 1968 there was only a brief information exhibition accompanying the colloquy (2–8 August 1968), but not all the artworks were computer generated. In 1969 different exhibitions were organized, and one of them was *Kompjuteri i visuelna istraživanja* (*Computer and Visual Research*) at Galerija suvremene umjetnosti (Gallery of Contemporary Art) in Zagreb (5 May–30 August, 1969): see Rosen et al. [12].

27 *Teorija Informacija i Nova Estetika/The Theory of Informations and the New Aesthetics, Bit International, n.1* (1968).

28 Among them, we should include Nake: See Frieder Nake, "Information Aesthetics: An Heroic Experiment," *Journal of Mathematics and the Arts* **6**, Nos. 2–3, 65–75 (2012).

29 Silvio Ceccato, *Cibernetica per tutti* (Milano: Feltrinelli, 1968). On the spread of information aesthetics in Italy, see Emanuele Quinz, "Arte verificabile. Esthétique et théorie de l'information: Italie 1962–1972," in *L'espace des images. Art et culture visuelle en Italie 1960–1975* (Paris: Manuella, 2022).

30 Frieder Nake, "The Semiotic Engine: Notes on the History of Algorithmic Images in Europe," *Art Journal* **68**, No. 1, 76–89 (2009).

31 The only Italian computer artist working in the same period was in fact Edvard Zajec, who actually worked in the USA and only returned to his hometown, Trieste, in 1970.

32 On Centro Ricerche Estetiche see Irene Caravita, *La fotografia nelle gallerie private di Milano (1967–1975)* (Rome: De Luca, 2022).

33 Achille Bonito Oliva, ed., *Latitudine/longitudine* (Marciana: 1969).

34 Achille Bonito Oliva, ed., *Ventunoundicisessantanove* (Milan: Diagramma Arte Contemporanea, 1969).

35 "Disegnare con numeri a caso. Strutture grafiche create matematicamente dall'elaboratore," *Informazioni IBM*, No. 5, 6–8 (1971).

36 Francesca Franco, "The First Computer Art Show at the Venice Biennale: An Experiment or Product of the Bourgeois Culture?," in *Relive: media art histories* (Cambridge, MA: MIT Press, 2013) pp. 119–134.

37 Umbro Apollonio, Luciano Caramel, and Dietrich Mahlow, eds., *Ricerca e progettazione: proposte per una esposizione sperimentale. 35. Biennale internazionale d'arte di Venezia* (Venice: La Biennale di Venezia, 1970).

38 Apollonio played an important role at Nove Tendencije: see Giovanni Rubino, *Elettricità e socialismo: arte programmata della nuova tendenza tra Italia e Jugoslavia (1962–1967)* (Rome: Efesto, 2021) pp. 159–195. See also Rubino [2].

39 *Computer Arts Society*, *Creative Computers*, exhibition program, 1970, AAL.

40 Ernesto Garcìa Camarero, *Generacion Automatica de Formas Plastica* (Madrid: Centro de Càlculo de la Universidad de Madrid, 1970).

41 Herbert W. Franke, *Computer Graphics, Computer Art* (London, New York: Phaidon, 1971). See also Herbert W. Franke, "Computers and Visual Art," *Leonardo* **4**, No. 4, 331–338 (1971); Herbert W. Franke, "Computer Graphics," *Graphis*, No. 161, 206–217 (1972).

42 Giorgio De Marchis, ed., *Italianische Kunst Heute* (Vienna: Tusch-Druck, 1971).

43 Tommaso Trini, "Arte fra tecnologia e tecnocrazia," *Rivista IBM* **VII**, No. 4, 14–25 (1971). Another relevant example is the first computer art exhibition in Italy in 1972, curated by Kathe Schröder and organized by the Goethe Institut. Pietro Grossi was in fact the only Italian among many international names: See Herbert W. Franke, ed., *Computer e arte. Grafica, scultura, musica, film* (Munich: Goethe Institut, 1971).

44 Silvio Ceccato, "La comunicazione estetica," *Rivista IBM* **7**, No. 4, 26–31 (1971).

45 The Department was headed by Michael Arbib, who, in 1972, published *The Metaphorical Brain: an Introduction to Cybernetics as Artificial Intelligence and Brain Theory* (New York: Wiley-Interscience, 1972). The book is illustrated by Auro Lecci, but the drawings are not computer generated.

46 The computer used for this work was a CDC 3600.

47 Auro Lecci, "Das auf einer Syntax beruhende Bildprogram ARCLINK 1970–72," in *Apparative Kunst. Vom Kaleidoskop zum Computer* (DuMont Schauberg: Köln, 1973) pp. 232–237.

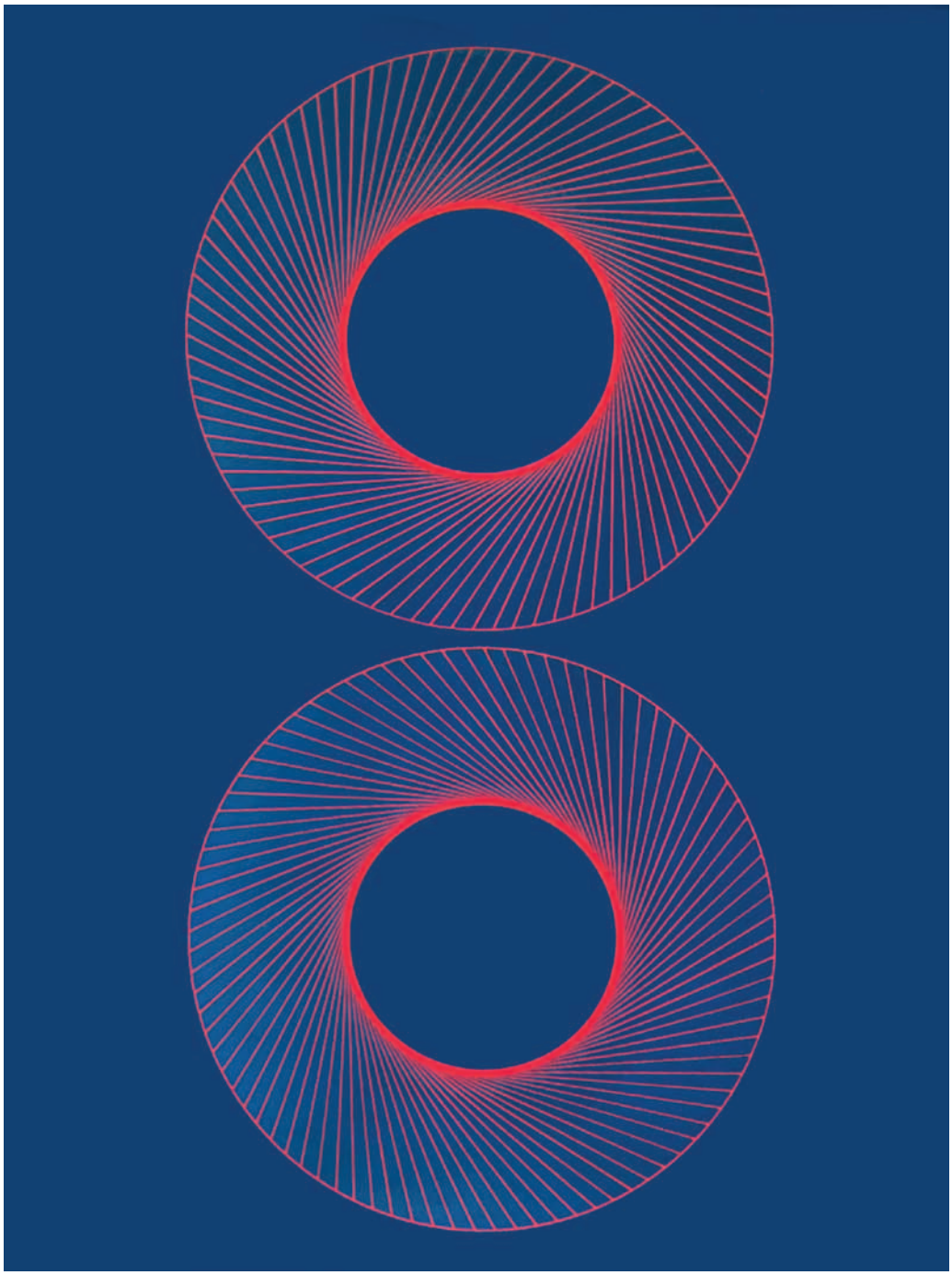
48 *Tendencije 5* (Zagreb, Galerija Suvremene Umjetnosti, 1973).

49 From conversations between the author and Lecci (March–June 2022).

Manuscript received 23 December 2023.

PAOLA LAGONIGRO *holds a PhD in History of Contemporary Art from the Sapienza University of Rome where she lives and works as a researcher.*

COLOR PLATE C: **AURO LECCI'S ALGORITHMIC ART: TOWARD THE COMPUTER AS A THINKING MACHINE**



Auro Lecci, *Inversione*, 1966, casein tempera on paper and wood panel, 46 x 61 cm (© Auro Lecci). The painting exhibited at Ipotesi linguistiche intersoggettive has been lost. A black and white reproduction, published in the exhibition catalogue, reveals a great similarity to *Inversione*. (See the article in this issue by Paola Lagonigro.)