a cura di Emanuele Pellegrini

It doesn't take much to introduce A. Michael Noll, Professor Emeritus of Communication at the Annenberg School for Communication at the University of Southern California. This is partially because his website (http://noll.uscannenberg.org/) is so well organized and rich with information, especially with regards to his biography, his activities, his publications; anything you want to learn about his career and scientific research can easily be found there.

However, Michael Noll needs little introduction primarily because he is considered one of the fathers of computer art, his artistic activity occupying a very special role within XXth Century history of art. In fact, Noll's name comes up literally every time we speak about computer art or art productions connected with computers: since the very beginning of the Sixties he has been experimenting with computer generated art, and he was one of the first people in the world to investigate the possibility of drawing by machine.

For both these reasons it is a real honor and privilege for us to publish in our magazine «Predella» this interview with Michael Noll, and a short biography *Early years at Bell Labs (1961-1971)*, dated September 30, 2011, that professor Noll sent us. The questions are only ten, very few if we consider the great amount of themes that can be discussed with him, and the many topics regarding which we would be curious to know Noll's opinion.

From his side, Noll's answers are very short, but fascinating. Each one contains valuable insight and will certainly instigate further research regarding crucial topics such as the relationship between visual art and technology, particularly in terms of computer media. This theme is especially relevant today not only in terms of its links with artistic creation but also the perception and fruition of art.

Reading Michael Noll's words regarding computer art means having the opportunity to learn about a scientist that made one of the greatest contributions to the development of computer artwork applications. The implications on the American art world, the beginning of the cartoon

industries, 2D, 3D and 4D animation and feedback and interaction between man and machine are only a few of the topics that can be connected to the development of his artistic research. Michael Noll clarifies here the main goals of his research at Bell Labs and more generally speaking he illustrates his relationship with some of the leading personalities in the New York art scene during the same period. His brief *essay* recounting his experience at Bell Labs contributes to a better understanding of the kind of experiments that were carried out and the cultural context in which they occurred, as well as the importance of computer graphical output to the development of computer art.

We hope that this text will prove to be a concise but useful contribution to the investigation of the beginning of computer art and of the relationship between art and computers. We simultaneously aspire to enrich the research of art and technology, a theme increasingly and integrally entrenched within our society.

Ten questions to A. Michael Noll

1. You started your experiments in computer art at the Bell laboratories in New Jersey in the early Sixties. What were the aims of those first experiments? Were they based on aesthetic interests or curiosity?

The aim of my initial work in digital computer art was to demonstrate the potential for digital computers in the visual arts: still images, 3D animation, 3D sculpture, and ballet.

2. Did Norbert Wiener's studies on Cybernetics or Abraham Moles' *Information Theory* play a role in your research?

No. I was well aware of Cybernetics by Wiener, but his theories had nothing to do with my computer art. Years later I heard of the work by Moles – but his work had no influence or relevance to my computer art, then or now. In my opinion, information theory has been misapplied to the arts to which it has no relevance then or now. Dr. John R. Pierce of Bell Labs wrote much about this kind of misapplication of information theory, and Pierce certainly influenced my opinion.

3. Was there any peculiar cultural or intellectual inspiration that led you towards computer art, specifically in terms of Gestalt theory in the context of art?

I was led to computer art because of my overall interest and knowledge of modern art. I was not aware of “Gestalt theory” then – and even today I would question its relevance to art. I did my computer art for my own enjoyment – not for any theoretical purposes.

4. Do you think that your first computer generated picture was influenced in particular by any type of visual language, such as that employed by Picasso or Mondrian, or Rothko, or Pollock or beyond?

I was well aware of Picasso cubism from my visits to the Museum of Modern Art. Although I initially was not attempting to “copy” cubism, my initial works did remind me of cubism. Later I did deliberately “copy” some op-art by Riley to show the potential for programmed digital computers to generate op-art imagery. I also deliberately attempted to mimic a painting by Mondrian since it consisted of short bars in black and white and thus was much in the style of what could be mimicked fairly easily using the computer. Of course, Mondrian placed his bars in a human fashion, but the computer placed its bars using a random algorithm.

5. In 1965-1966 you created a computer generated Mondrian piece, and then put it beside a reproduction of the real Mondrian painting, asking people which one they preferred or if they were able to distinguish the computer generated example from the original Mondrian. What were the aims of that "Mondrian experiment", and do you still consider the results valid?

The aim of the Mondrian experiment was to determine whether a computer-generated image would be as preferred as a painting by Mondrian – and also whether people could somehow determine which was done using the computer. The majority of the subjects in the experiment

preferred the computer-generated image and believed it to be by Mondrian. I would guess that these results would be valid today if the experiment were replicated. Later I programmed a series of these Mondrian-like images to determine whether there was a preferred amount of randomness. I believed that computer-generated images could be used as stimuli in investigations of aesthetic preferences.

6. In your opinion, did the first experiments in computer art have a wide impact on other artistic experiences, not only within visual arts such as painting or sculpture, but also art forms like dance, cinema or music?

In the end, our early work in computer art affected many artists. Although some believed in collaboration between artists and programmers, I always believed that a new breed of computer artist would emerge. I did not believe in collaboration.

7. What was your relationship with the New York artistic scene? Did you have any connections with artistic life of New York, in particular during the Sixties?

In 1965, Bela Julesz and I exhibited our computer-generated images at the Howard Wise Gallery in New York City. I also spoke and showed my work at various colleges and also to various dance organizations in New York City and elsewhere.

8. Did you have any relationship with or influences from the world of animation, especially in terms of cartoon industries, like Disney?

Roy Disney visited Bell Labs in the 1960s and was shown our work in computer animation. He saw no relevance of it to Disney – a huge lack of vision on his part. My computer-generated ballet consisted of basic stick figures moving about on a stage in 3D.

9. Nam June Paik visited the Bell Laboratories during the Sixties: do you think that your experiments could have had an impact on the development of video art?

My work had no influence of video art. However, Paik did attempt to learn computer programming from me and spent a few days studying with me. However, the discipline of programming escaped him.

10. We live in an era of incredible development of computer technologies, potentially deeply influencing the way in which we consider visual arts and create artwork. What is your opinion regarding the development of computer art, from the very beginning to the present?

Most major museums still seem to ignore computer art. A major use of digital computers has been in animation and also in advertising and also in television for titling and other effects. I used my 4D animation technique to generate the title sequences for a commercial movie around 1967 and also for a television special colorcast on NBC around 1968.

November 3, 2011

COMPUTER ART AT BELL LABS

A. Michael Noll

December 4, 2011

Digital Computer Art – Beginnings in 1962

The program I wrote at Bell Labs to perform cepstrum analyses of speech signals generated huge amount of graphical output from the IBM 7090 computer. This output was plotted automatically on a Stromberg Carlson SC-4020 microfilm plotter. This device consisted of a 35-mm camera that photographed a cathode ray tube on which the graphs were drawn using vector graphics.

Other summer interns were also using the microfilm plotter to display their data. One was a doctoral student from MIT – Elwyn Berlekamp. A programming error produced random graphical nonsense, which he jokingly called computer art. I can still remember him running down the hallway with his “computer art!”

My reaction to this unintentional “art” was to create it intentionally. I did this by writing FORTRAN programs for the IBM 7090 computer that combined elements of mathematical equations (order) with subroutines that calculated number that appeared random to humans. The “patterns” were then plotted on the Stromberg Carlson microfilm plotter on 35-mm microfilm. The microfilm could then be printed on paper. I wrote a Technical Memorandum describing this computer art; this MM-62-1234-14 was dated August 28, 1962 and entitled “Patterns by 7090.” I had wanted to call the images “computer art” but my management insisted on the more neutral description “patterns,” somehow believing that only the art world could determine what was “art.”

I recall that I would take paper versions of one of the patterns that I particularly liked – called “Gaussian-Quadratic” – and would color over the lines with colored makers. I would put my initials on these and then give them to my colleagues to hang in their offices as computer art. “Gaussian-Quadratic” has a cubist quality in the shapes formed by the lines. It reminded me of Picasso’s “Ma Jolie” which I liked from my visits to the Museum of Modern Art in New York City.

I wondered whether the digital computer could be programmed to mimic art done by a human. I chose a black-and-white painting by Piet Mondrain that consisted of vertical and horizontal bars. I wrote a program to mimic this painting but with the bars placed randomly. I then showed

copies of both the Mondrain and the computer image to 100 people at Bell Labs, asking them which they preferred and which they thought was done by Mondrian. The computer version was preferred and thought to be the Mondrian! I published the results of this classic study [“Human or Machine: A Subjective Comparison of Piet Mondrian’s ‘Composition with Lines’ and a Computer–Generated Picture,” *The Psychological Record*, Vol. 16. No. 1, (January 1966), pp. 1-10]. I believed that computer art could be the stimuli in investigations of aesthetics and the subjective preferences of people for art.

Computer Stereographics

As a child, I had 3D stereographic viewers and enjoyed them very much. It was obvious to me that this technique of separate images for each eye could be adapted to the digital computer and the 35-mm microfilm plotter. I wrote the software to perform the stereographic projections of three-dimensional data and viewed the 35-mm images in a handheld stereo viewer. Some of the data was scientific, such as 3D speech spectrograms. But I also applied the technique to random artistic shapes – a form of computerized 3D sculpture [“Stereographic Projections by Digital Computer,” MM-64-1234-2, March 10, 1964].

Edward E. Zajac programmed the IBM computer at the Labs to generate an animated movie of a satellite orbiting the earth. The movie was generated on the microfilm plotter and was one the earliest computer-animated movies. I learned years later that similar computer animation had been done at the Lawrence Livermore Laboratory – so I am not sure who has the claim to “first.” Frank Sinden at Bell Labs did a computer animation of planetary motion.

It occurred to me to program the IBM computer to generate stereographic animations. A colleague told me about a Prism-Stereo attachment for a movie projector for 3D movies in which the separate left and right images were placed head-to-head on each frame. I programmed the computer to calculate the stereographic projections and then plot the images head-to-head for viewing with the Prism-Stereo attachment. I programmed random 3D objects that changed shape [“Computer-Generated Three-Dimensional Movies and Pictures,” MM-66-1234-1, January 20, 1966].

I liked to attend ballet performances in New York City. While attending Balanchine's ballet of Stravinsky's "Apollo" it occurred to me that the computer could be programmed to create stick figures in 3D as a tool for choreographers. The friend attending the ballet with me was a dancer, and she told me about various dance notation methods. Thus the first computer-generated ballet was programmed in 1965. I recall showing the movie to various dance organizations in New York City, including the Dance Notation Bureau, Rebecca Harkness, and the New York Council on the Arts. I wrote an article on the technique ["Choreography and Computers," *Dance Magazine*, Vol. XXXXI, No. 1, (January 1967), pp. 43-45]. A 2D version of the ballet is in the permanent collection of the Dance Library at Lincoln Center.

A mathematician at Bell Labs (Dr. Doug Eastwood) suggested to me that I create a 3D movie of a rotating four-dimensional hypercube. Another colleague (Dr. Man Mohan Sondhi) helped with the mathematics, and the animated stereographic movie of a rotating hypercube was created ["A Computer Technique for Displaying n-Dimensional Hyperobjects," MM-67-1234-2, February 21, 1967; "A Computer Technique for Displaying n-Dimensional Hyperobjects," *Communications of the ACM*, Vol. 10, No. 8, (August 1967), pp. 469-473.].

I liked the 4D motion, and placed letters and words in the four-dimensional space to be projected into 3D and then into 2D. This technique was used to create the title sequence for a movie about Bell Labs, called "Incredible Machine," and might be one of the earliest uses of computer animation to create title sequence. A year or so later, I used the technique to create the title sequence for the TV special "The Unexplained" produced by Walt DeFaria and written by Arthur C. Clarke ["Computer Animation and the Fourth Dimension," *AFIPS Conference Proceedings*, Vol. 33, 1968 Fall Joint Computer Conference, Thompson Book Company: Washington, D.C. (1968), pp. 1279-1283].

A sister research department was studying human hearing and models of the basilar membrane in the human inner ear. I used my stereographic animation program to create a 3D movie of computer-simulated motion of the membrane using data supplied by Dr. Robert C. Lummis and Dr. Sondhi. Some researchers at the Brookhaven National Laboratory created data of molecular motion, which I then used to create a 3D movie.

At the Labs, Dr. Michael C. King had an idea on how to create a hologram using the 3D images that I created. This was perhaps on of the first computer-generated holograms, and we described the method in a published paper ["A New Approach to Computer-Generated

Holography," (with M. C. King and D. H. Berry), *Applied Optics*, Vol. 9, No. 2, (February 1970), pp. 471-475].

Howard Wise Gallery Show (1965)

Howard Wise operated an art gallery in New York City on West 57th Street. He had a particular interest in technology in art and exhibited "op art" by Dr. Gerald Oster. Somehow, Wise saw the random-dot stereograms that were produced by Dr. Bela Julesz at Bell Labs (possibly as a result of a Scientific American article) and approached Julesz about an exhibit of these patterns at the Wise Gallery. Bela was aware of my work in computer art – both 2D and 3D. Accordingly, Bela asked me to join him in this exhibit with Wise. Bela always felt that his patterns were scientific with no artistic merit – I felt that my patterns were artistic with no scientific merit.

Bela and I met with Howard to determine the terms of the exhibit. We ultimately agreed to split the profits of any sales after deducting the costs of mounting and printing any of the patterns. In the end, not a single work was sold!

Bela and I believed that the show would be impressive positive publicity about the innovation and creativity of Bell Labs. AT&T owned Bell Labs and had a very different opinion. AT&T was concerned that the show would seem frivolous and generate negative publicity about how Bell Labs was wasting money and resources. Accordingly, AT&T attempted to cancel the show. But Wise had already announced it and threatened to sue. Bela and I were ordered by AT&T to avoid the media and any publicity.

The Bell Labs legal folks suggested that Bela and I copyright the works to be exhibited in our own names. That way the media could not copy and publicize the works. Thus Bela and I added the copyright symbol and our initials to each piece. I realized that Bell Labs was giving up any ownership rights to the works.

I submitted “Gaussian-Quadratic” for registration at the copyright office at the Library of Congress. I mentioned in the description of the work that it was computer art. The copyright office replied that the work of a machine could not be copyrighted. I explained that a program that I –a human – had written generated the work and that the program combined elements of mathematical order with randomness. The copyright office then stated that random works could not be copyrighted. I explained that the “randomness” was calculated by the program and only appeared “random” to us. The copyright office relented, and “Gaussian-Quadratic” became perhaps the first example of copyright registration of digital art.

The Howard Wise show was announced with a small package of IBM cards. This misled one critic into believing that the patterns would be IBM-card like – I doubt if this critic ever actually attended the showing. The show “Computer-Generated Pictures” took place from April 6 through April 24, 1965. There were other works being shown in another portion of the Gallery, but I do not recall whether that was a special show or just usual Gallery artists.

The 35-mm microfilm originals were photographically enlarged as prints, which were then mounted on masonite by Modern Age studios in New York City. Bela and I also exhibited some of our 3D stereographic images. These were mounted as polarized prints with rear illumination. Poloroid glasses were available to view the 3D images. Howard Wise was responsible for mounting all the works for the show.

I realize now that starting with a show on West 57th Street is really starting “at the top.” This showing of digital computer art was perhaps the very first major public showing of digital computer art (certainly in the US) – although I later learnt that Georg Nees in Germany had a showing of his computer art a few months earlier in 1965, followed at the end of 1965 by an exhibition in Germany by Frieder Nake and Georg Nees.

I recall that later in 1965 I travelled to Las Vegas for a showing of my digital computer art (jointly with analog Lissajous patterns by Maughan S. Mason) at the Fall Joint Computer Conference.

Diversions

Dr. Max V. Mathews, who pioneered much of the use of digital computers in music, and I visited the studio of the video artist Nam June Paik on Canal Street in New York City. Paik's studio was full of television sets that had been modified to produce interesting images. He manipulated magnets to distort the images on the face of the cathode ray tubes. We invited him to the Labs to see what we were ding with computer art. Paik attempted to learn with me how to program the computer, but computer programming was far too removed from his methods of creating visual art, although he did spend a few days with me.

Charlotte Moorman was Paik's close friend, and she was the organizer for the yearly New York Avant Garde Festival. She also was a cellist – noted for performing it topless. She too visited the Labs, and many of us became participants in her yearly Festivals. I recall a parade down Central Park West in which she was suspended from a balloon while playing her cello.

Interactive Computer Graphics

I continued my work in computer art and published papers describing it with the objective of interesting artists in the artistic possibilities for using digital computers ["The Digital Computer as a Creative Medium," *IEEE Spectrum*, Vol. 4, No. 10, (October 1967), pp. 89-95; "Computers and the Visual Arts," *Design and Planning 2: Computers in Design and Communication* (Edited by Martin Krampen and Peter Seitz), Hastings House, Publishers, Inc.: New York (1967), pp. 65-79; "Art Ex Machina," *IEEE Student Journal*, Vol. 8, No. 4, (September 1970), pp. 10-14]. I also spoke at many conferences and other places. I recall visiting Leslie Mezei at the University of Toronto and making a presentation there with Marshall McLuhan in the audience. McLuhan asked a question, but no few in the audience understood him. Neither did I, but I attempted an answer, and we had some sort of discussion that went over my head but which seemed to satisfy him.

Around 1967, my interest in computer art subsided with the arrival of a dedicated digital computer in our department for our own use, thanks to the wisdom of our department head, Dr. Peter Denes, who realized that time-shared computing was not then practical. We therefore had

our own Digital Equipment DDP-124 computer – later to be replaced by a DDP-224 machine.

I applied my interest in 3D to this computer. With the help of Charlie Matke—a mechanical genius who worked in research – we designed and constructed 3D input and output devices. The 3D input device was a 3D joystick that moved in rectangular coordinates. I wrote a 3D stereographic program to display left and right images in real-time on the CRT display attached to the DDP computer. This was one of the first interactive 3D computer environments [“Software Package for Real-Time Interactive Computer Graphics on the Honeywell DDP-224 Computer,” MM-68-1234-3, June 6, 1968; “Interactive Stereoscopy,” MM-70-1234-10, December 11, 1970]. Max Mathews used the 3D input device for his work in computer music.

Computer graphic displays used vector graphics to draw lines and images. However, it took time for the electron beam to be positioned to draw the lines and vector objects from one point to another. This therefore limited the amount of information that could be drawn and displayed in real time. The solution was to use a scanned display method, like in television. I wrote a program to perform the conversion from vector information to the information needed for a scanned display – one of the first such uses of scanned computer graphics [“Scanned Display Computer Graphics,” MM-69-1234-8, November 21, 1969]. Bell Labs applied for a patent for this invention – but was ordered by AT&T to abandon it rather than pursue the case to the US Supreme Court because of the controversy about patenting a computer program. The Bell Labs patent attorney (Al Hirsch) was in tears over this disappointment. With the help of Jack (D. J.) MacLean, we also made a color scanned display.

A film animator from Canada visited Bell Labs and wondered whether it would ever be possible to communicate with the computer through hand gestures and shaping objects. Instantly the idea occurred to me to motorize my 3D input device to give force feedback. I wrote a memorandum describing this idea for tactile communication with a computer [“Man-Machine Tactile Communication: Computer Graphics for the Blind,” MM-68-1234-2, April 10, 1968]. I designed the force-feedback device and had it constructed by the machine shop at Bell Labs [“Man-Machine Tactile Communication,” MM-71-1234-6, June 8, 1971]. I programmed the DDP-224 computer to control the device, and this research became the topic of my doctoral thesis at Brooklyn Poly.

In June 1971 I received my Ph.D. in Electrical Engineering and left Bell Labs to join the staff of the Science Advisor (Dr. Edward E. David, Jr.) at the White House. My work at Bell Labs in computer art, 3D computer graphics, and tactile communication came to an abrupt end.