Bell Telephone Laboratories, Incorporated: An Early Digital Media Lab

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AN EARLY DIGITAL MEDIA LAB

The term "media lab" is much in vogue today, but, although not always called that, media labs have a long history – all the way back to Thomas Alva Edison in the late nineteenth century.

Although he conducted research in a number of areas, Edison had, in effect, the first media lab, beginning in the late 1870s, at his research and development facilities in Menlo Park and West Orange, New Jersey. Edison and his researchers were responsible for such media innovations as motion pictures, the phonograph, and the carbon microphone. That was yesterday's world of analog media.

Much of the world of today's digital media came from innovations made during the 1960s at Bell Telephone Laboratories, Incorporated (Bell Labs) in New Jersey. In fact, much of today's digital era came from research done at Bell Labs – such as information theory, digital sampling, digital compression, the Unix operating system (in addition to such hardware innovations as the transistor and the CCD imager).

Bell Labs was responsible for research and development (R&D) for the Bell System, which decades ago had a monopoly for the provision of telecommunication services in the United States. The official organization Bell Telephone Laboratories, Incorporated was formed in 1925 and existed until 1984 when the Bell System was broken apart into a number of separate entities. The American Telephone and Telegraph Company (AT&T) and the Western Electric Company owned Bell Labs jointly – although AT&T supported most of the fundamental research done at Bell Labs. Today, Alcatel-Lucent's R&D unit continues the tradition of Bell Labs.

Before the Bell breakup, the research portion of Bell Telephone Laboratories, Incorporated was only about 5% percent of the total R&D effort, and included fundamental research in such areas as chemistry, physics, and mathematics. In the 1960s, digital computers were still somewhat novel and were just becoming a major tool

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[2] Noll was a Member of Technical Staff as a research engineer at Bell Telephone Laboratories, Incorporated during the 1960s. This article is based upon his personal knowledge of the digital work done at the Labs.

for data analysis and research – their use in media was just beginning. The term “digital media” had not yet been coined back then.

Employees of Bell Labs performed research related to acoustic and visual media. Although some of them had training and their own interests in music, animation, and art; and could themselves be considered composers and artists, Bell Labs was primarily interested in the technology – not the content – of music, art, and animation.

Today we hear much about “media labs” at various universities and companies. However, one of the very first digital media labs was at Bell Telephone Laboratories, Incorporated in Murray Hill, New Jersey. Employee researchers and visiting composers and artists performed their work there – before “computer science” and “digital media” had become accepted terms. This history from the 1960s should not be forgotten and is reviewed in this article.

COMPUTER MUSIC

Max V. Mathews – a Bell Labs engineer and researcher -- was responsible for the creation of the facilities used for electronic and digital music. He reported to John R. Pierce – another engineer with an interest in electronic and digital music. Decades later, in retirement, they would both work together at the Center for Computer Research in Music and Acoustics (CCRMA) at Stanford University. It was Mathews who brought many composers and artists to Bell Labs. Mathews developed the MUSIC IV software. William H. Ninke was responsible for developing the Graphic 1 system at Bell Labs around 1967 with its light pen and cathode ray tube for display and which was used with MUSIC IV.

Joseph P. Olive studied physics and music theory and composition at the University of Chicago and performed research in language, speech, and signal processing at Bell Labs. F. Richard Moore studied music at the Carnegie Institute of Technology and in 1967 became a research programmer at Bell Labs. They both composed digitally at Bell Labs. Joan E. Miller was a mathematical acoustician at Bell Labs who studied the spectrum of violin tones and the digital synthesis of speech and was also a violinist.

In addition to the research employees working in digital media, many composers and artists visited Bell Labs, where they either worked on their own or worked with the employees on various music and art projects. Some of the visiting composers who worked on digital music included Jean-Claude Risset, James Tenney, Emanuel Ghent (who was also an MD psychotherapist), and Laurie Spiegel. Others who visited Bell Labs for a day or so to see the work being done there in applying digital computers to music included the conductors Leopold Stokowski and Hermann Scherchen.

COMPUTER ANIMATION & ART

In 1962, Bell Labs engineer A. Michael Noll (the author of this article) realized that the digital computer could be used to create artistic patterns based on algorithms – and that

year programmed the IBM 7090 computer at Bell Labs to do so. He would later create stereoscopic computer animated movies of dynamic sculptures and even a computer-choreographed ballet. His works, along with patterns done by Bela Julesz, were shown in 1965 at the Howard Wise Gallery in New York City. The graphic output was created on 35 mm microfilm by a Stromberg Carlson SC-4020 cathode-ray-tube plotter.

Bell Labs computer scientist Kenneth C. Knowlton developed a programming language for manipulating blocks of data and used this BEFLIX language to create a computer-animated movie in 1964. A year later, animator Stan VanDerBeek visited Bell Labs and worked with Knowlton on a number of computer-animated artistic films. In the early 1970s, Knowlton worked with artist Lillian F. Schwartz on artistic movies utilizing computer-animated sequences. Graphic designer Aaron Marcus came to Bell Labs around 1967 and programmed his own computer art.

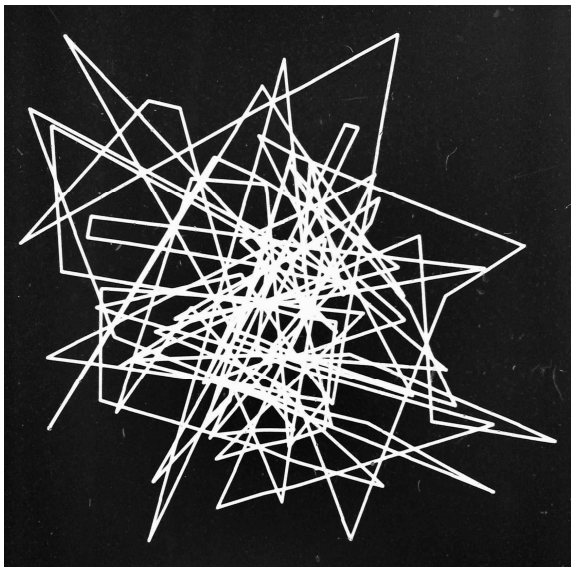

Fig. Random lines (white on black), programmed in 1962 by A. Michael Noll at Bell Telephone Laboratories, Incorporated.

Bell Labs researcher Edward E. Zajac in 1963 programmed a very early computer-animated film depicting a communications satellite in orbit. Researcher Frank Sinden programmed computer-animations of the physics of planetary motion around that same time. Although their computer-animated films were made to depict scientific topics, the animations themselves had an artistic dimension.

Researchers Leon Harmon and Knowlton together developed gray-scale methods on black-and-white displays in which many small images were used to create larger mosaics. Their technique resulted in one image “The Nude” that achieved notoriety and was shown in late 1968 at the Museum of Modern Art in New York City.

Researcher Jerry Spivack utilized a digital computer to create imagery used in an interactive piece he created to be shown at the Brooklyn Museum in late 1968. Around that same time, Bell Labs physicist Manfred R. Schroeder created computer art from complex mathematical equations. In addition to the work done by employees of Bell Labs, various other artists visited Bell Labs, such as Nam June Paik, who worked with Noll.

INTERACTIVE LAB

Peter B. Denes saw the importance for research that would come from an interactive environment in using a dedicated digital computer. Hence, he acquired a Computer Control Company (CCC) DDP-124 computer, and later a Honeywell DDP-224 computer. This computer was intended primarily for research into human speech, and was equipped with graphic facilities to display speech parameters and with various input devices to manipulate data and parameters.

The input devices included a small box with knobs and switches and also a three-dimensional joystick. The 3D joystick could input three-dimensional spatial information and then be displayed on a stereoscopic attachment to the CRT display. A raster-scan computer display was invented in the late 1960s, initially in black-and-white and then in color, and used for art and animations. In the early 1970s, a force-feedback apparatus was devised to create a virtual environment for feeling shapes and objects.

Mathews and Moore created a computer-controlled music synthesis system, called GROOVE, using the DDP-224 computer. Composers (such as Ghent and Spiegel) used this system and the box and joystick to control parameters for their digital musical compositions. Artists and animators used the box and joystick to manipulate and specify imagery that was displayed on the scanned display and captured on a movie camera. Spiegel developed her own programming language for animation and Knowlton developed a package of subroutines for animation on this interactive system in the 1970s.

JUSTIFICATION AND SUPPORT

The research and development work done at Bell Labs was restricted to communications – not music and art. So how then was this work in digital media justified and allowed?

The work in digital computer music was justified because it dealt with sound, and thus was relevant to understanding and synthesizing the speech signals carried over telephone facilities. The work in animation and graphics was justified as a more effective way to present scientific and technological data, and possibly as a form of man-machine communication to be carried over telecommunication facilities. However, AT&T nevertheless sometimes questioned the work in music and art. But Dr. William O. Baker (who was the vice president of Bell Labs responsible for research) always

defended the work. Actually, it was Dr. Baker who created the open environment for innovative research at Bell Labs during the 1960s – its so-called “golden years.”

The composers and artists who came to Bell Labs wanted to be there for access to the facilities and creative researchers there. There were no formal programs choosing which outsiders were allowed access – decisions were made on an ad-hoc basis. Management allowed it, as long as it did not interfere with the “real” research being performed. However, the music and art frequently acted as a stimulus to technological innovations in digital sound, art, and media – and this ultimately benefitted science and technology.

The programmers, scientists, and engineers doing the digital media research published many papers and articles, in addition to making presentations of their work to professional organizations, universities, and others. This was done to educate and interest artists, musicians, and others about the exciting possibilities for digital computers in the arts broadly.

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VIDEO LINKS

A good overview of the digital media work done at Bell Labs in the 1960s is the documentary film “Incredible Machine,” made by AT&T in 1968 and available at the AT&T Tech Channel website (http://techchannel.att.com/play-video.cfm/2011/4/22/AT%26T-Archives-Incredible-Machine).

Computer animation of a rotating four-dimensional hypercube in stereoscopic 3D that Noll programmed around 1965 -- http://www.youtube.com/watch?v=iXYXuHVTS_k

Computer-animated movie done in 1964 by Kenneth C. Knowlton of Bell Telephone Laboratories -- http://techchannel.att.com/play-video.cfm/2012/9/10/AT&T-Archives-Computer-Technique-Production-Animated-Movies