Art and Science: Two Worlds Merge

Through centuries of civilization, the artist has used technical knowledge, but now scientists are finding that working with artists can broaden their own thinking in creative technology.

In this day of intensifying specialization, people often think of art and science as two completely disparate, even mutually exclusive, disciplines — areas of human endeavor as opposite as poles of the earth. And yet, a new affinity between the two is drawing together people who, until recently, might never have met. It is as though the rivers of science and art have reached a point of confluence where scientist and artist are intermixing in a mutually fruitful exchange of ideas.

Active in this confluence are a number of men at Bell Telephone Laboratories. What they are doing and their reasons for collaborating with artists are as diverse as the technical projects they are working on. Equally diverse are their feelings about interaction with the artist. Their point of agreement is that they all feel it is growing, that it is important, that technology contributes to art and that art is, and may become even more important to technology.

At Bell Laboratories, scientists studying the fields of speech, hearing and visual perception have become absorbed in the world of the artist in many ways directly connected with their work. Much of this scientific exploration enlists the aid of the computer, which is becoming more and more useful as a graphic tool not only in research but also, somewhat unexpectedly, in creating new art forms.

Occasionally, basic research has led to artistic by-products from the scientists themselves. The "sculptures" of A. Michael Noll, which were exhibited at the Howard Wise Gallery in Manhattan, grew out of his research into computer-generated three-dimensional graphs and movies that compare mathematical models with reality and depict phenomena that are not directly observable. The precedent for this was Mr. Noll's creation of moving or "kinetic sculptures," which are made by describing their shapes and dimensions in numbers. He has also programed the computer to generate drawings composed of quasi-random elements in the style of abstract painter Piet Mondrian.

Obviously excited by the computer's possibilities as an artistic medium, Mr. Noll envisions the artist of the future working with the computer by direct man-machine interaction. "The creative potentialities of

the computer result in a totally new kind of artistic medium — a creative medium with which the artist can interact," he says. "The potential of such a medium as collaborator with the artist is truly exciting."

Also exhibited at the Howard Wise Gallery was work done by Bela Julesz, who is concerned with basic research in visual perception at Bell Labs. He has created a computer movie of random patterns with texture which dramatizes visually the relationship between textures of physical objects and perception of their shapes.

The difference is motivation

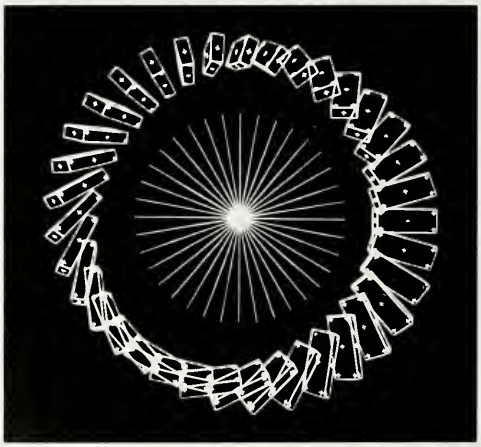
Mr. Julesz says, "When the scientist starts to see that some of his creations become artistic and are accepted at more than their scientific value, as a piece of beauty, it's an unusual experience. While these computer movies were intended for a study of visual perception, not as art, I think that visual perception is historically a common area for both the artist and the scientist, a common intersection where there is no gap or artificial bridge. The same kinds of things can be artistic or scientific; the only difference is the motivation.

"The artist is searching for an artistic truth, an intimate truth he wants to convey," Mr. Julesz goes on, "and I am searching for a scientific truth, which is testable and very defined. The artist is also interested in solving problems, and the computer might be a common tool to bring us together because it helps to execute the problem. It has made us more aware of the interaction between science, technology and art."

Kenneth Knowlton, another scientist at Bell Laboratories, has specialized in computer-produced motion pictures. He has devised a special programing language called BEFLIX, which permits the technologist to present a visualization of what he wants to explain. In collaboration with film maker Stan Vanderbeek, Mr. Knowlton has produced a one-minute film, "Man and His World," which, without story line, is a series of patterns with color background, created entirely by the computer.

Of this collaboration, Mr. Knowlton says, "It is teaching me something about art, about expressing myself, freeing up my own thinking so that I no longer think in nearly so stereotyped a way about the computer and the things one can do with it. Stan Vanderbeek has been using the BEFLIX movie language extensively; he is learning programing techniques so that he can push ahead with experimental computer movies."

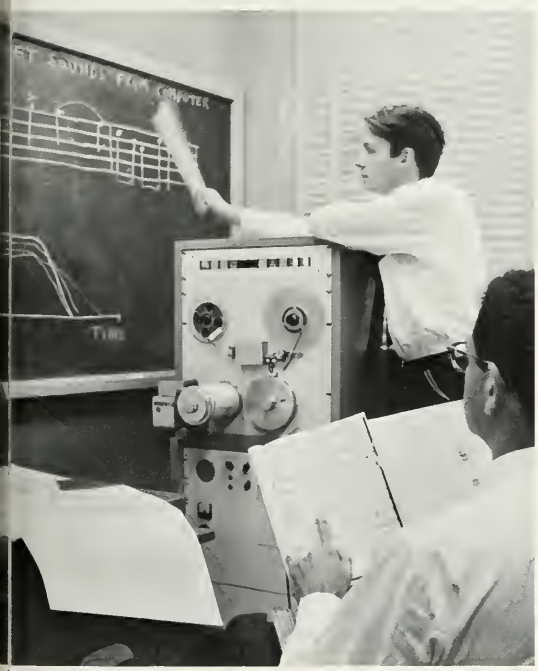
Mr. Knowlton considers that Vanderbeek's experience in presenting things visually through his films has helped in producing technical movies with the computer. "Vanderbeek thinks in visual terms," says Mr. Knowlton. "He's interested in color, motion, after-images, patterns; in making a film he has to consider all these. When I began making films with the computer I was not aware of these considerations. Vanderbeek is teaching them to me — I now appreci-



Composite still from computer movie made at Bell Laboratories represents a communications satellite making one orbit of the earth. This helps scientists design attitude control systems.

ate their importance in communicating visually, whatever the content of the film. I think that any scientist using the computer to make movies can profit from the seasoned film maker's knowledge and experience."

While these men — Noll, Julesz, Knowlton, and others at Bell Laboratories — in the course of their research have produced computer-generated images of artistic merit and interest, their primary objective still is research. Specifically, they are concerned with exploring the computer's manifold capabilities and its potential uses as a research tool. For example, Frank W. Sinden, a colleague at Bell Laboratories, has produced a series of computer-generated movies which attempt to isolate those three-dimensional effects that we detect entirely through motion or time sequence. As these researchers point out, their experience with the artist's point of view has provided a useful feedback into their own work — a kind of yeast in the cake of pure science. But the ultimate value of this experience, for them, will lie in its stretching of the horizon of research.



Translating movement into sound

Manfred Schroeder, director of Bell Laboratories' acoustics, speech and mechanics laboratory, a year ago participated in an experimental entertainment called "Nine Evenings: Theater and Engineering." This was a collaborative project between dancers, artists, musicians and technologists. Engineers and scientists at Bell Laboratories contributed their technical expertise, working on their own time, to produce a fusion of music, painting, dance, abstract sound, film and live television.

"I became involved," says Mr. Schroeder, "because I am familiar with all kinds of sound effects. Acoustics is my speciality, and part of the endeavor here was to integrate acoustic effects into these performances. Dancer Lucinda Childs was asking for things to translate body movements directly into sound, so that she could actually create her own accompaniment as she danced. We came up with a device that reflected ultrasonic waves from her body, then converted them to audible sound. I got the idea from work I'd done years ago on stabilizing public address systems, and feedback problems with the Speakerphone, which under certain conditions produced howling or singing noises. It wasn't a very interesting sound. But while we were working with it we discovered that it would make all kinds of funny sounds if you did the

Jean Claude Risset, visiting French physicist and composer, demonstrates trumpet tune synthesized by computer. This is part of continuing research in the basic properties of sound and speech.

right things to it and if people walked through the room. When Miss Childs made her request, I remembered that work. But," he adds, "it needed some artistic concept to make it worthwhile and enjoyable."

Mr. Schroeder considers that such new uses of technology have a real future in artistic expression. "We certainly have a great storehouse of scientific information that would allow us to produce a variety of acoustical and visual effects. For example, we could have sounds whirl around in space, or we could have this translation of movement into sound, or light into sound, or sound into light."

Computers could simulate dancers

"We could use digital computers to simulate a certain effect. One could write a computer program to simulate not only one dancer and a microphone, but also do the same thing for a troupe of 50 dancers. We could give the choreographer knobs on the computer console to change the movements of the dancers and hear the differences in sound — give him the possibility of altering his original idea."

Although he thinks of himself specifically as an engineer, in connection with "Nine Evenings" Mr. Schroeder foresees a more intimate interaction between art and engineering in the future. "I think it is quite conceivable," he says, "that we will have mixed personalities here, that artists in these fields will emerge from the engineering profession."

Another of the people at Bell Laboratories who has been actively engaged in collaboration with artists is Billy Kluver, who conducts laser research in the Physical Optics and Electronics Research Department. Mr. Kluver has worked with way-out kinetic sculptor Jean Tinguely, sculptor and film maker Andy Warhol, painter and sculptor Robert Rauschenberg, composer

Bell Laboratories' Billy Kluver arranges helium-filled pillows at a recent show dramatizing the merging of art and technology, which Mr. Kluver considers "a natural marriage."

John Cage, painter Jasper Johns, and others. He was a major motivating force behind the "Nine Evenings" project and worked with its performers in his spare time. While the show's mixture of sound, light and motion effects never before heard or seen evoked mixed responses from audiences, Mr. Kluver considers it a fruitful experience for all concerned.

The common ground where engineer and artist meet is illuminated more clearly when Mr. Kluver speaks of his own involvement. "The artist's work is like that of the scientist; it is an investigation which may or may not yield meaningful results.

"The artist and the scientist both work with the world around them; their perception of this world is their material. Their differences lie in the way in which they use this material. The scientist must build on and include previous scientific knowledge in his work. The artist, once he has made his choice as to the essential character of his work (be it painting, sculpture, music), will make every effort to avoid easy associations or connections with other works of art or other known fields of human activity. When you see a good work of art for the first time, it gives you the feeling of not relating to anything else you know — yet you are forced to become aware of it. I am interested in art as an engineer, not as an artist."

From his own experience as a technologist working with artists, Mr. Kluver says, "You do things you wouldn't normally do, because you're in touch with a mind whose vision is totally different from yours. The artist's vision and concern relate to other aspects of human activity, and that's the end that particularly interests me. I'm not so much interested in helping artists as I am in seeing what effect the artist could have on technology. In the future, I see the artist having more and more impact, as he learns more about technical processes. The contribution of the artist could conceivably lead to an increased awareness, a new view of the problems the engineer, designer, scientist has to deal with. For instance, it might reflect on questions like: What should the next mass media look like? We will have the megalopolis; what is it going to look like? I think that the main influence of art and technology together will come in the area of environment."

By-products of research

It is perhaps in the field of sound — especially computer-produced sound — where the interaction between artist and technologist has been closest. Sound and music created by the computer are by-products of research in new techniques for transmitting voice and music over telephone and other communications systems. The potentialities of this "machine music" are being examined by many musicians and mathematicians at Bell Laboratories and elsewhere, including MIT, Princeton University, Stanford University, UCLA, and the Argonne National Laboratory.

Among those practicing musicians who have come to Bell Labs for aid in their explorations are Gerald Strang, member of the Music Department in the California State College system; composers Milton Babbitt and James Randall of the Princeton University music faculty; Vladimir Ussachevsky of Columbia University; and James Tenney of Brooklyn Polytechnic Institute. There were also the late Edgar Varese and Herman Scherchen.

Meanwhile, some Bell Laboratories researchers have themselves become composers, including John R. Pierce, executive director of the Research Communications Sciences Division, Max V. Mathews, director of the Behavioral Research Laboratory, and Newman Guttman, formerly of Acoustics Research.

Mr. Pierce, who is a writer of both fiction and articles, and a poet as well as a composer, says of his first adventure in computer music, "The first computer-played music was composed by Newman Guttman and programed by Max Mathews as an experiment in producing and using certain voice and other sounds. It was just a little flyer. I wondered whether a computer had to sound like that, or whether it was what

Newman had done. So I dug out a very short little conventional piece that I had composed and ran it through the computer, and it sounded more like conventional music."

New insights into acoustics

Pierce and Mathews started using the computer to make "musical sounds," and that led them into amateur composing and eventually into the issuing of a record. Mr. Pierce emphasizes that it was the challenge of something new that made it exciting. "I have never untangled the art and the science in living," he says. "I certainly wouldn't have bothered to compose little ditties and I never would have gotten them on a record if it hadn't been for the computer. The only thing that led me to do this was curiosity — the chance to exploit and play with something entirely new. It was fascinating. It has inspired me, informed me."

Mr. Pierce points out that such excursions into computer-generated sound have led to new understanding of sound quality and acoustics. "Since Max Mathews and I devised various ways in which the computer generation of sound could be made more flexible," he says, "there has been a continued interaction among the psychoacoustics of perception, the study and production of speech, and our experiments with musical sounds.

"In my case," he goes on, "I have become more sensitive to, and have a greater appreciation of, sound quality. I've been interested in the generation of speech from phonetic symbols stored in the memory of a computer. I regard this as a very important and challenging problem in the field of man-computer interaction. Some of the experiments I have made with musical sounds have led me to believe that it will be possible to overcome the mechanical quality of computer-generated speech. Our studies of the quality of violin tones and trumpet tones are very closely related to our studies of the quality of computer-generated speech."

At present, spoken words produced by the computer are limited by the difficulty of describing the essential features of such complex sounds precisely. Here, Mr. Pierce considers the uniquely human sensitivities to be indispensable. "One of the most powerful human faculties," he says, "is that of being able to judge qualities even when we cannot measure them. Here the ear of the trained musician may be as valuable as the digital computer. We are looking for needles in haystacks, and only the sharp ears of musicians and the sharp minds of scientists will enable us to find them."

Max Mathews, a specialist in behavioral psychology, has worked with several composers in computer techniques, and has composed music himself. In particular, composers Randall, Tenney and Strang are writing music for the computer because, as Mr. Mathews says, "musicians can't play the music they write or wish to write. It is too precise and too fast, and requires things that are physically impossible." Using a sound synthesizing computer program which Mathews developed, these composers write out a score, specify the sounds they want synthesized, and the results can be heard through a loudspeaker connected to the computer as though emanating from an orchestra.

Collaboration is a two-way street

In Mr. Mathews' opinion, collaboration between artist and technologist is, in a very real sense, a two-way street. "What the technologists get out of art are the same things that anyone else gets out of art, the same thing civilization gets. These are the very important, long-range permanent values; they represent some of our best achievements."

The scientist may also derive benefits unique to his own situation. "As far as unique things are concerned," says Mr. Mathews, "this depends upon him as an individual: he may get quite a bit of inspiration; he may get new ideas; he may get some idea from the

Artist Robert Rauschenberg and dancer Lucinda Childs, performers in last year's "Nine Evenings" entertainment, discuss unique electronic environmental system with Bell Laboratories engineers Leonard J. Robinson and Per Biorn.

art that he can use directly in his technology. We have, certainly, examples of this in the understanding of speech and speech quality that have come out of our studies in music.

"Currently, we have been concerned with experiments on tone perception, a new theory of consonance and dissonance, which was primarily studied for music. The sounds and the percepts are the same musically and speechwise, and music is a much simpler sound source, so we can study it in greater detail and understand it better. These tonal studies have given us a new insight which we would not have gotten directly from speech because it is too complicated."

Whatever course the converging rivers of art and technology may take, it seems certain that the convergence is permanent. The new windows now being opened by science and art working together are broadening the view to the mutual profit of both.

"Deeper understanding," Mr. Pierce says, "has broken down many of the barriers between various fields of science. Perhaps this will become true of the barriers of ignorance and temperament which have divided science and engineering from the arts. This could surely open new opportunities for artists, and I really believe that it can quite as much open the eyes and ears of engineers and scientists — and even their minds."

Max Mathews emphasizes succinctly, from the scientist's point of view, what the collaboration between the scientific community and the world of art means to him: "You get inspiration from working with the artists, generally wake up. And this is one of the requirements for doing creative research — to be awake!"

It may have been the eventual fruits of such collaboration that Sir Francis Bacon had in mind when he wrote: "The real and legitimate goal of the sciences is the endowment of human life with new inventions and riches." □