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Foreword

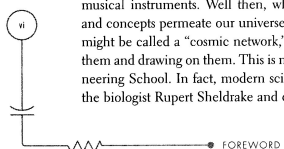
ROBERT MOOG

MUSICAL INSTRUMENT DESIGN is one of the most sophisticated and specialized technologies that we humans have developed. Even the drums and pipes of our distant ancestors were among the most highly developed artifacts of their time. More recently, bowed and reed instruments were assembled from unlikely combinations of materials, each of which was meticulously shaped as a component of a complex structure. Among products that matured in the industrial manufacturing environment of the eighteenth and nineteenth centuries, the piano and the saxophone are unique both in the ingenuity of their design and the precision of their manufacturing processes. Thus, when we speak of musical instruments today, we understand that we are talking about precisely made and finely tuned objects.

On the other hand, musical instrument design has always been at the fringe of technology, far from mainstream practices that stress ease of manufacture, predictability, and economy. Materials such as the woods, glues, varnishes, and catgut of string instruments or the alloys used to make cymbals are selected for properties that defy objective specification; and component pieces, like the neck of a cello or the body of a bassoon, are contoured with organic complexity. Testing and adjustment are largely a matter of human judgment, rather than the application of rulers and gauges. In fact, some of the finest musical instruments are so special and idiosyncratic that nobody has ever learned how to replicate them exactly.

How can it be that musical instruments are both sophisticated technological devices and quirky artifacts that often seem to border on the irrational? I believe that the answer lies in how musical instruments are used. Music-making requires both the musician and the listener to function at the very limits of their perceptive and cognitive capabilities. Therefore, a musical instrument has to be as effective as possible in translating the musician's gestures into the sonic contours that he is envisioning. When he performs, the musician feels his instrument respond as he hears the sounds that it produces. In terms of modern information theory, the musician-instrument system contains a multiplicity of complex feedback loops, so complex, in fact, that contemporary technology has so far not been able to analyze or characterize the nature of the instrument-musician interaction with precision or completeness. Thus, it is not possible to design a musical instrument by beginning with an objective set of performance specifications. Rather, a musical instrument design usually begins with a designer's intuition. In some manner, this intuition suggests to the designer that a certain arrangement of materials will result in an instrument with desirable sound and response characteristics.

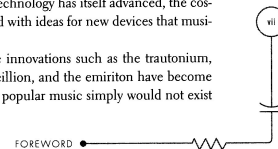
Now we get to a tricky question: Where does the intuition come from? Does one attend a major university to learn it, or study reference books? Does one pick it up from a teacher or master? Can you develop it from experience, just by experimenting? How about learning from one or more musician-collaborators? Are you perhaps born with it? The answer to all these questions, I believe, is "Yes, to some extent." They all may contribute, but no one source accounts for all the intuition you need to make good musical instruments. Well then, what else is there? I believe that ideas and concepts permeate our universe and our consciousness, forming what might be called a "cosmic network," and some of us are adept at noticing them and drawing on them. This is not something you learn about in Engineering School. In fact, modern science is just now, through the work of the biologist Rupert Sheldrake and others, addressing the question of how



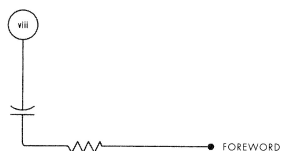
some of us seem to be aware of events at some distance in space and time. This can explain why technical innovations frequently seem to pop up simultaneously in different places. As you read through this book, you will come across several clear examples of the phenomenon of "shared intuition."

Electronic musical instrument technology during the past century has developed through the contributions of many intuition-inspired innovations. At the beginning of the twentieth century, even before the invention of the vacuum tube, the patent attorney and inventor Thaddeus Cahill envisioned a music production and distribution system in which tones were produced by 15-kilowatt electrical generators and distributed over wires similar to telephone lines. With investors' backing, Cahill actually installed such a system in midtown Manhattan. Known as the telharmonium, his system was not a commercial success, but it did foretell the development of the Hammond organ, the electronic music synthesizer, and Muzak. Just a few years after the introduction of the triode vacuum tube, Leon Theremin noticed that whistles from an improperly adjusted radio could be varied by hand motion. From that, he proceeded to develop the space-controlled electronic musical instrument that bears his name. (By the way, Theremin was also the first to develop color television, during the same period that he did his groundbreaking work with electronic musical instruments.) Another early visionary, Maurice Martenot, used circuitry similar to that used by Theremin to design a strikingly innovative keyboard-controlled instrument. Throughout the 1930s and continuing after the Second World War, dozens upon dozens of innovators developed novel electronic musical instruments of all sorts. As electronic technology has itself advanced, the cosmic network has constantly hummed with ideas for new devices that musicians could play.

Few of the early electronic music innovations such as the trautionium, the hellertion, the crea-tone, the oscillion, and the emirton have become widely accepted. In contrast, today's popular music simply would not exist



without the music technology of the past half century or so. Why have most early electronic musical instruments fallen into obscurity, while many recent developments such as the keyboard synthesizer, the phaser, and the fuzz box have become part of the growing electronic musical instrument industry? Rapidly evolving electronic technology is only part of the answer. The complete answer must take into account the evolution of the cultural environment in which we are immersed. Just as a musician interacts with her instrument as her music evolves, technology and our culture are constantly interacting as they themselves evolve. The stories in this book, of how synthesizers came into being, provide fascinating and revealing insights into how technical, commercial, and cultural trends shape one another. In addition, I believe you will find that the stories also shed light on the cosmic network, and how it contributes to human creativity and innovation.



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