Toward a Machine with Interactive Skills

While Boston and its environs slept away the predawn hours of a November morning in 1961, Ivan Sutherland, doctoral candidate in electrical engineering at the Massachusetts Institute of Technology and computer programmer extraordinary, sat engrossed at the console of the TX-2 computer in the basement of M.I.T.'s Lincoln Laboratory. He was at work on his dissertation project, a computer drawing program he called Sketchpad. The name derived from the proclivity of engineers to rough out an idea on a scrap of paper, then gradually refine it by making innumerable revisions. Sutherland was convinced that he could turn the computer into a superior tool for this process.

Sutherland was only one of many researchers captivated by the interactive possibilities of the TX-2, so he had to scramble for a share of the computer's precious time, even if that meant getting out of bed at two or three in the morning. The solitude of his sessions at the computer did not bother the 23-year-old Sutherland; in some ways it suited his personality. Brilliant and idiosyncratic, he was known as a man who went his own way. He could focus his formidable powers of concentration and shut out anything extraneous. "It wasn't that he was unfriendly," an acquaintance explained; "he just zeroed in on whatever he was involved in. If you were at his house and it was time for him to go to bed, he would get up and excuse himself and tell you to lock up when you left. That was just his way."

On that November morning, Sutherland's left hand hovered over a box studded with closely spaced push buttons. In his right he held a light pen that resembled the light gun invented more than a decade earlier and used on the Whirlwind computer. Sutherland held the tip of the light pen to the center of a computer monitor, where he had programmed the word "ink" to appear. At the touch of the pen, the word was replaced by a small cross. Sutherland then

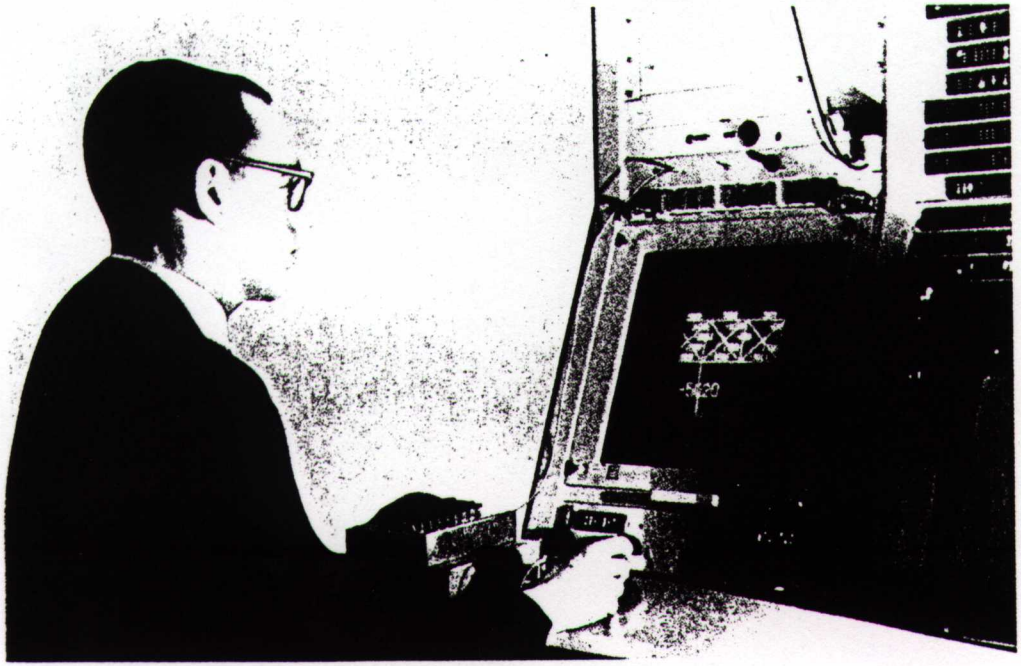
Stripped to structural basics, an Air Force F-15 jet fighter is shown as a three-dimensional wire-frame model on a high-resolution vector monitor. Vector displays are used by designers and engineers in many fields to isolate and clearly identify components.

punched one of the push buttons and began to move the light pen. As he did so, a bright green line appeared, stretching from the center of the cross to the pen's new position. Wherever he moved the pen, the line followed, like a rubber band with one end tacked to the center of the cross and the other attached to the pen. With a second push-button command, the line remained frozen on the screen as Sutherland moved the light pen away.

Modest as it may seem a quarter of a century later, the line was proof of an extraordinary accomplishment. In a stroke, Sutherland had extended the practical applications of interaction between human and computer. Sketchpad was a masterly synthesis of two different branches of developmental effort. The first was work done by programmers on the TX-2 and its predecessor, the TX-0, to develop software that gave these machines limited line-drawing capabilities. Sutherland also utilized programming techniques invented for the APT (Automatically Programmed Tools) System, an early computer-aided manufacturing system that used a computer to control tools for milling pieces of equipment.

Realizing that computer graphics could have significant applications in engineering and design, Sutherland bent his efforts toward increasing the operator's control of the image on the screen. Where an operator at the TX-2 could draw simple shapes on the screen with a light pen, the shape could not be manipulated. "In the past," Sutherland explained in the technical report on Sketchpad that M.I.T. published in January 1963, "we have been writing letters to rather than conferring with our computers."

In contrast, Sketchpad promised to turn the computer into a tool that anyone might use. Even at this early stage, the program allowed someone with no programming experience to solve complex engineering problems through the



Sitting at the console of the Lincoln Lab TX-2 computer, programmer Ivan Sutherland uses the Sketchpad graphics program to manipulate a bridge design. This pioneering interactive program, devised by Sutherland in 1961, enabled users not only to draw and erase on the screen but also to demonstrate the results of engineering tests. Commands were entered with the light pen in Sutherland's hand and the push buttons to his left.