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STAR WARS

THE EMPIRE STRIKES BACK

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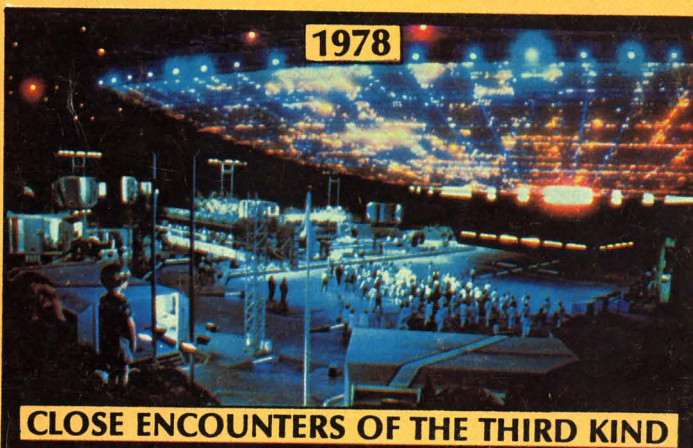
1977

STAR WARS

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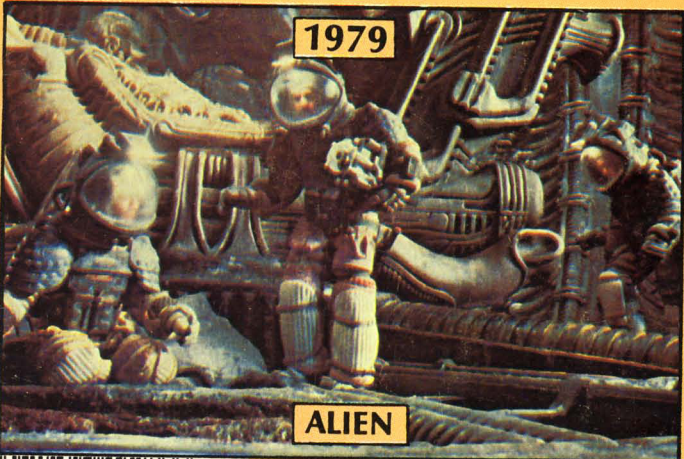
1980

THE EMPIRE STRIKES BACK

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...Animating the
Death Star Trench...

For Larry Cuba, the 40 second animation of the Death Star Trench in Star Wars was no small task — It took months of programming and over twelve hours of shooting time — that plus the University of Illinois and a language called GRASS. His job: to **simulate the pilot's mission with a point of view shot from the Death Star approach to the flight down the trench at its surface. The problem: the trench had not yet been created when the effect was needed.**
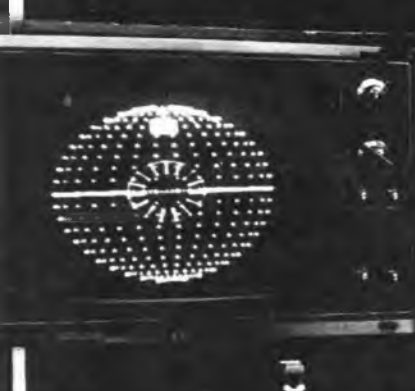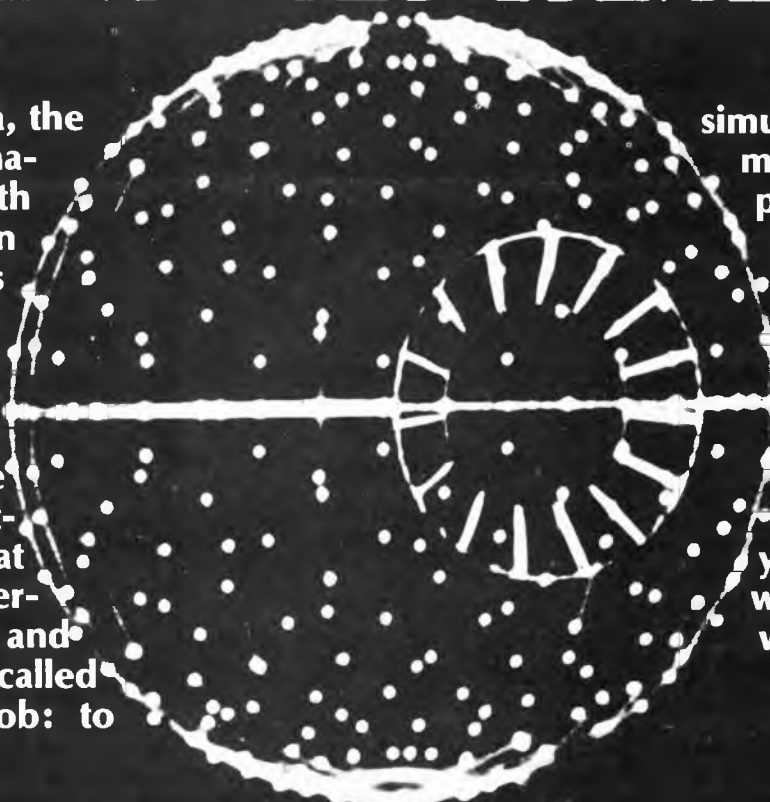
The computer schematic of the Deathstar created by Larry Cuba hovers above its own image on the video display screen.

General Dodonna stood before the starpilots and navigators of the rebel forces—the spectre of the dreaded Death Star, headquarters of the Empire, uppermost in their minds. They did not have much time. "The Imperial Empire's battle station is approaching from the far side of Yavin. It must be stopped once and for all," was the General's command. "Its defenses are designed around a direct, large scale assault. A small, one man fighter should be able to penetrate the outer defense."

Luke and the others assembled in the long narrow room watched the computer screen as it displayed a simulated view of the one flaw in the Death Star. The General gestured towards the diagram of the mission as he explained how the Empire could be attacked.

"You're required to maneuver straight down this trench and skim the surface to this point," the General indicated. "The target area is only two meters wide. It's a small thermal exhaust port. The shaft leads directly to the reactor system. A precise hit will start a chain reaction that should destroy the station. . . . Man your ships and may the force be with you."

The computer schematic helping General Dodonna explain the destruction of the Death Star to Luke Skywalker, Han Solo and the others of Star Wars' rebel forces was actual-ly a piece of film being rear projected onto the rebels' computer screen. It is the only example of digital computer animation in the entire Star Wars film. On the screen for a bare forty seconds, it is nonetheless the result of months of work. It utilizes the best in

"Man Your Ships And May The Force Be With You."

computer hardware technology—and makes use of a unique software system that enables the computer to be used not only for the creation of art but as a new educational tool as well.

For Larry Cuba, assigned the task of filming the sequence, the problem was a tough one. His job was to simulate the pilot's mission with a point of view shot from the approach to the Death Star to the flight down the trench at its surface. The schematic was to match the reality of the trench itself in all its complexity—but unfortunately, the trench had not been created at the time the effect was needed for the film.

Basically, there are two ways an effect such as this can be created in a film—the sequence on Dodonna's screen could have been optically filled in on the film after the live action was shot—the classic "blue screen" method, whereby the rebels' computer screen would have been a solid blue to allow later superimposing of the animation sequence; or, the sequence could be rear projected and filmed as a unit. Lucas wanted the second approach—perhaps to keep a feeling of reality and continuity. But, since most of the special effects were completed after the live action shooting (a piece of animation showing the exhaust port and shaft of the Death Star which ran right after Larry's scene, for example, was completed a full six months later), Larry had to proceed with what he had.

What he had were examples of each of the six component modules of the Death Star trench, and, in some cases, photographs. But most important, he had the use of an incredible computer animation set up at the Circle Graphics Habitat of the Chemistry Department at the University of Illinois in Chicago.

Larry Cuba is a 27 year old computer filmmaker from Los Angeles, currently a Research Associate of the Art Department at the University of Illinois. Born in Atlanta and a former St. Louis architectural student, Larry had decided to be a computer filmmaker and had worked in Los Angeles (with computer film pioneer John Whitney) as a programmer.

Profile by NEESA SWEET

Larry was no stranger to the U of I—he'd been there before because of the work going on and partly to use the set-up, including a new computer language called GRASS. GRASS was to play a major role in the Star Wars sequence.

The Graphics Habitat system at the Circle is a blending of computer and television technology that opens the doors of computer creation to educators, artists and anyone else, whether they know computer programming or not. Instead of having to program in each command, a series of analog instruments in the set-up allow the operator to form a direct relation with his actions and the image on the cathode ray screen. At the U of I, it's used by professors and others who want to create unique visual presentations for their classes. The system provides a simple and reinforcing way of creating images that can vary in length, width, and height, and be changed over time as well as in brightness or color. It's a fun system to use—like a "three dimensional chalkboard" says Larry—and that encourages its success.

At the heart of the system is a Vector General 3DI cathode ray tube with dials, light pen and an electronic tablet. This device draws lines from points fed to it from the minicomputer to which it is attached. The minicomputer is a PDP 11/45 model with a desk unit and input keyboard. It performs the actual computations necessary to make pictures.

The dials, light pen and electronic tablet of the Vector General allow the operator a direct relation between his actions and what is seen on the screen. For example, a figure can be called up and manipulated; or, an image can be traced on the tablet; an electronic impulse will sense where the pen is at various periods of time, and the coordinates of those points will be picked up and transfered as an image, with connecting lines to the screen via the minicomputer.

At the Graphics Habitat, the Vector General and the minicomputer are hooked up to an "Image Processor" and other video equipment, allowing the operator to place almost any image desired on tape. In the case of Larry's Star Wars sequence, however, the ultimate output had to be on film. There was the capability of doing this directly off the screen of the Vector General (a standard Mitchell 35 animation motor tied to the computer, with the screen and camera under a

The camera is rolling in stop motion sequence, triggered by the computer, as each frame of the Deathstar trench is constructed on the cathode ray screen.
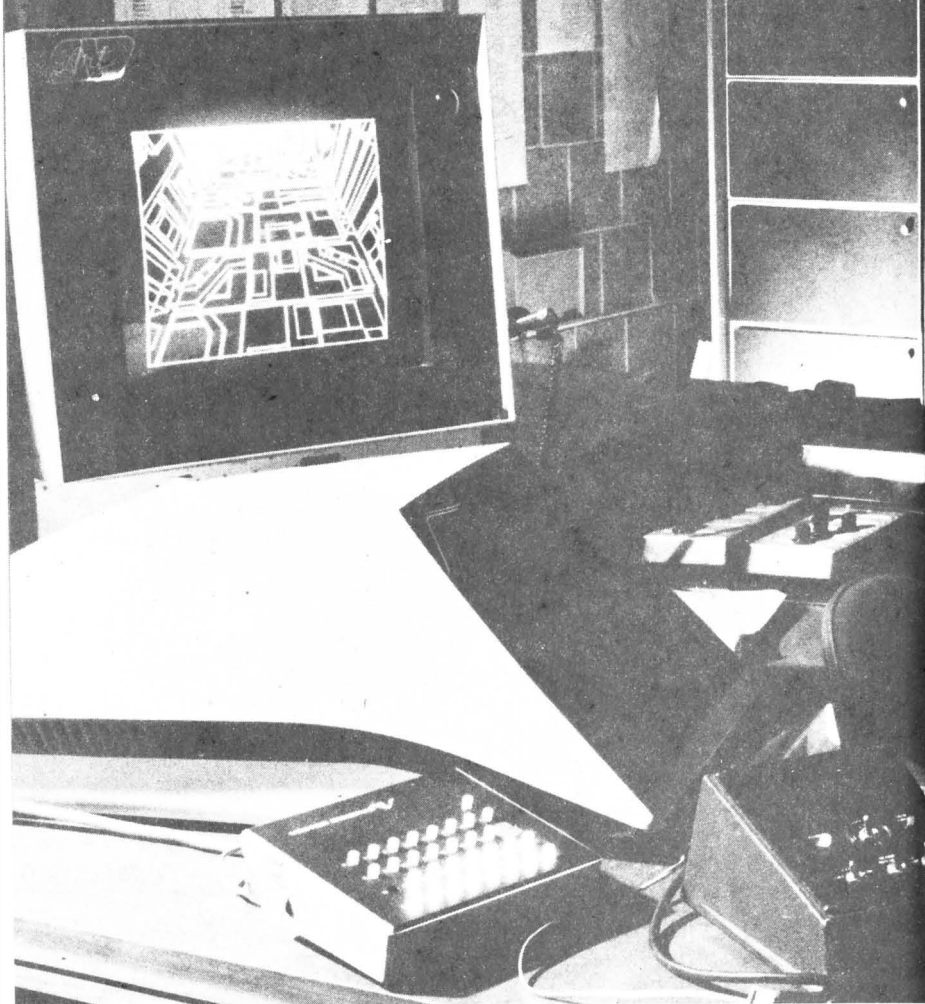
shroud for extra light protection was ultimately used) so the other components were not needed.

What was needed was GRASS. GRASS, of the Graphics Symbiosis System, is a computer language developed in 1973 by Thomas A. De-Fanti, then a graduate student at Ohio State University, as his doctoral dissertation. Tom's purpose initially was to provide a method for artists to explore computer art without the need or the help of a programmer. Today, Tom is a Professor of Information Engineering at the Circle and GRASS is a central part of the Graphics Habitat system. The basic idea of GRASS is to provide a system of easy to learn commands that can perform a variety of tasks with a minimum of repetition. For example on a demonstra-

tion of the language, Larry was able to call up a graphic representation of the chemical structure of a starch molecule (a hexagon), show it on the screen, rotate it on various axes and even add another stored figure, a propeller, and make it into an airplane type figure flying a path over the screen. The movements, locations, speed and angle of movement, are controlled by dials.

For Star Wars, Larry programmed his effect in GRASS, with a few necessary additions. On a previous visit to the U of I, Larry had written the tablet program that made possible the use of free hand drawings on the tablet. As the tablet transferred the list of points making up the shape or object to the computer, the points would be stored, so that the object
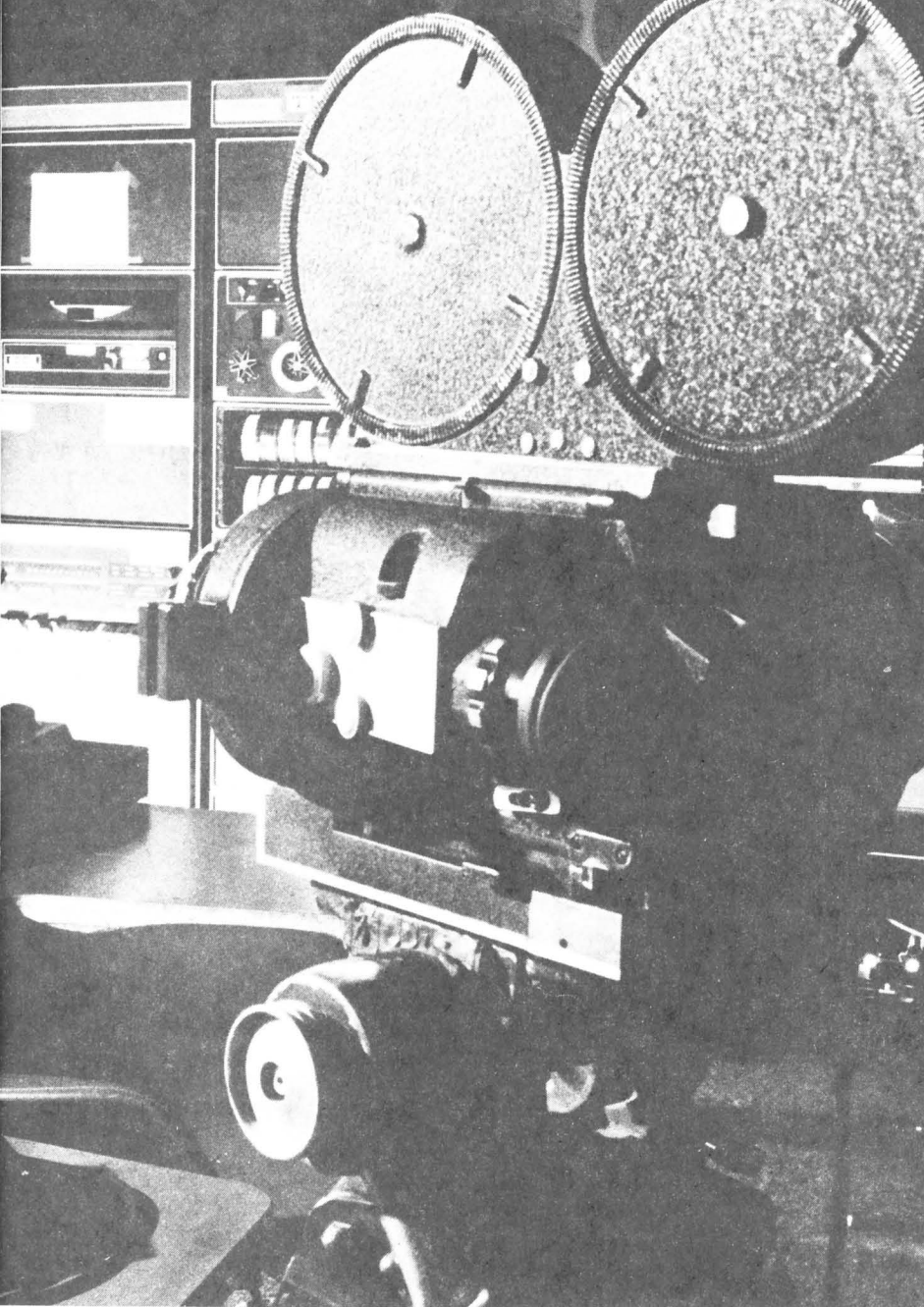
created appears on the screen and a cursor indicates the current position of the pen. The height of the point, or z coordinate, is entered separately by selecting one of the function buttons. Another button specifies whether or not a line is drawn between points and the display reflects this choice. To monitor the construction in three dimensions, the Vector General dials could be used to rotate it and examine it from all sides.

Once the six basic modules were stored in the computer, Larry wrote a program to combine the modules into larger structures. His computer version of the trench was constructed of u-shaped sections placed side by side. "To make one of these sections, I recalled a digitized module and positioned it using the dials," he explains. "Then, I added a second module and continued in this way until the "U" was formed. This completed figure could now be moved as a unit. To complete the trench, over fifty U-shaped sections were constructed in this manner and stored."

Once Larry had the components, each image that was to be part of the finished film had to be shot. It took about two minutes for each frame to be constructed—each shape was shown by the computer in perspective and combined with four others to form a single frame of the film. After the "construction" was completed for each frame, the program cued the camera, and the exposure was made. Two thousand exposures later, Larry had the finished film. Two minutes of time lapse photography coming from over twelve hours of "real time." Two minutes from which the forty seconds appearing on General Dodonna's screen was selected.

Larry first became involved with Star Wars a year ago January. Lucas was looking for computer animation. Larry showed a film of his called "First Fig," submitted a bid and got the job. He'd talked to Lucas before the director left for England, and he was spending time in Los Angeles collecting material and what he could get of the models.

Then he came to Chicago where he had come periodically to work with Tom's system. He began to work with two programmers, T.J. O'Donnell, and Tom Chomica, and a photographer to photograph the models—all students at the University of Illinois. It was an exacting task—every model had to be carefully measured, with the heights written down at the right

could be recalled any time the operator chose.

When the Star Wars work began, Larry had to rewrite his program so that, instead of just picking up two dimensional coordinates at every point, the program would stop and wait for a third, z, coordinate, or height to be entered. In this way, a three dimensional drawing could be placed into the computer to be manipulated by GRASS.

Larry worked basically from a photograph of mat painting of the Death Star. He created a computer picture by combining a number of circles and arcs. The circles in particular, were fairly easy constructions, as the program did include formulas for their representation. The figure thus created could be rotated

and made larger or smaller by manipulation of the dials.

"To complete the shot," said Larry, "I had to continue the pilot's view of the Death Star to include the flight down the trench to the target at the end. The trench shown in the film was made up of hundreds of models. Six basic shapes were used to form an actual trench forty feet long. At this point I worked from one each of the six basic modules and the photographs of the trench as it was being constructed."

First, a computer representation of each basic module was made. This process is called digitizing because numbers are used to indicate line endpoints. A photograph of each model is placed on the data tablet. As the pen is pressed, the object being

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points, so that when a point was entered into the computer, Larry would know which height to enter with the other coordinates.

Then there was the fact that the time he thought he had to complete the project was suddenly, and typically, cut short. At first, the studio had told Larry that they needed the film June 1—but when the studio in LA got the shooting schedule from England, there was the scene with General Dodonna planned for shooting in England on May 6. They called Larry and told him of the misunderstanding. The scene was going to be shot in two weeks. And not only that—they needed the film two weeks before the shooting to make registration prints. To keep to the schedule the way it was the film would have to be shipped that day.

The film at that point, of course, wasn't ready. Larry had little choice but to suggest doing the scene optically—but they still wanted rear projection. So the Los Angeles studio called England—and at the last minute the shooting schedule was rearranged to allow them to film the scene the very last day the crew had "command" of the large sound stage containing the rebel base. (The Star Wars crew had been using every available large sound stage in England and this was the biggest). It gave Larry a few more weeks—the film had to be mailed out on May 6.

Tom DeFanti, observing the situation, said that if all was done according to schedule, it would be a "miracle."

As May 6 approached, the situation became quite tense. And then, the hardware system itself kept breaking down. On trial after trial, Larry and his people tried everything. They removed the disk, cleaned it, took it apart—and 30 minutes later: *crash.* Something kept happening that would not let the program complete its run.

Larry had been working 20 hour days and sleeping in the lab. It was the Saturday night before the Monday that the film was due to be shipped out. Larry had already reached the decision that he was going to call Los Angeles on Monday and tell them that he was having equipment problems. They would have to go to an optical

Computer schematic of the Deathstar trench created by Larry Cuba. Taken from precise measurements of the trench models, 40 seconds of this film involved over 12 hours of stop motion photography, triggered by the computer program.
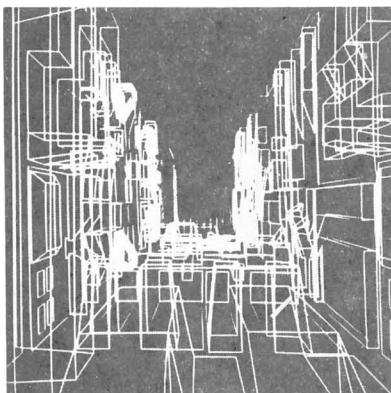
effect—there was no longer any choice.

It was midnight and Larry thought he would take a final nap in the lab. He thankfully turned the air conditioner down. The computer needs a constantly cool environment to function and for weeks Larry had been freezing. This nap at least was going to be comfortable.

About 3 in the morning Larry woke up — partly out of habit as his schedule had become one of sleeping three hours a night. He decided to try to run the program one more time.
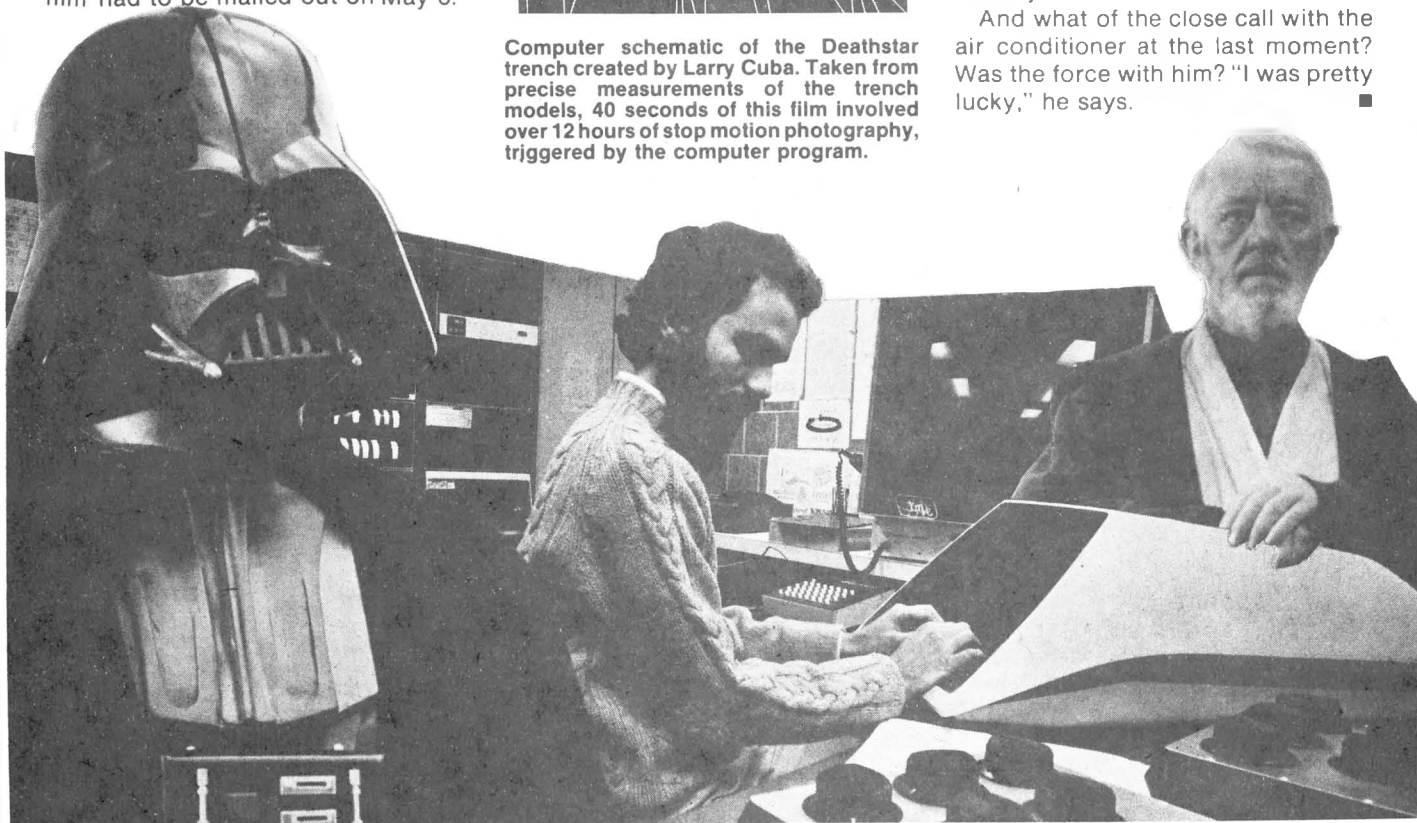
It worked perfectly. It seemed the computer had some circuit that had been *too*-sensitive. It only worked when the air conditioning was turned down for a time. The filming ran all the next day and was able to be shipped out on Monday, just in time for the shooting.

From then on, the effect was in England, and, as Larry found out later, things did not run smoothly there either. As Anthony Daniels, who played C3P0, told him later, it was quite a project to coordinate the animation with the live action. The pilots would be talking, they would turn around, and the wrong segment of action would be on the screen. It took quite a while for the whole scene to come together. But come together it did. The briefing was successful and the Death Star was ultimately destroyed.

And what of the close call with the air conditioner at the last moment? Was the force with him? "I was pretty lucky," he says. ∎

Larry Cuba at the controls of the Vector General, while the embodiment of the opposing powers of the force seem to prepare for the final confrontation.