OCTOBER 1969

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AMERICAN Cinematographer

International Journal of Motion Picture Photography and Production Techniques

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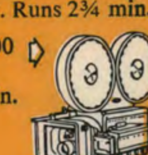

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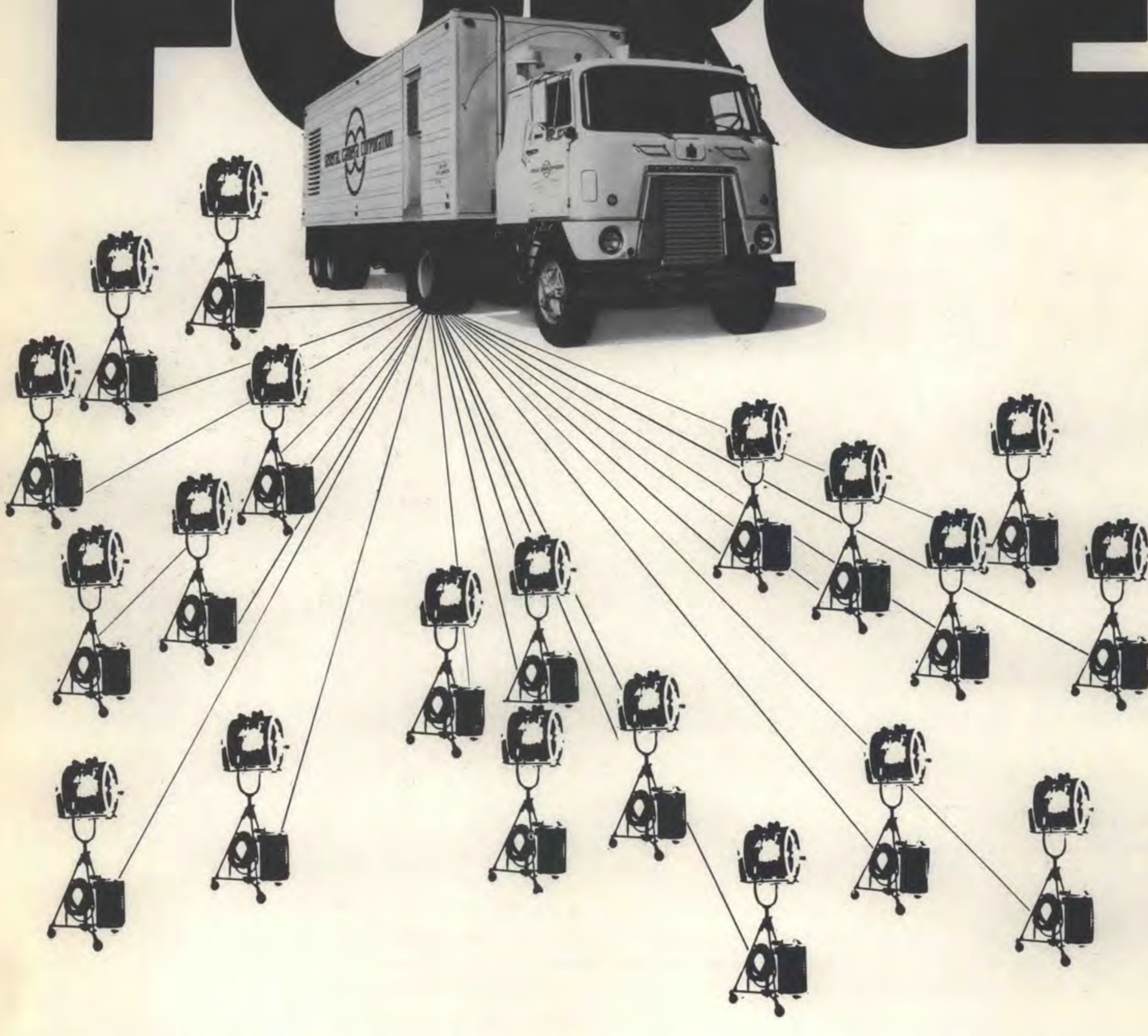

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AMERICAN
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International Journal of Motion Picture Photography and Production Techniques

OCTOBER, 1969

Vol. 50, No. 10

Editorial—Business Offices
1782 North Orange Drive
Hollywood, Calif. 90028
876-5080

Advertising Representative
Paul Gilbert
485 Fifth Avenue
New York, N.Y. 10017
297-5614

● **FEATURE ARTICLES**

ON THE COVER: A "light in space" design specially photographed for *AMERICAN CINEMATOGRAPHER* by Douglas Trumbull of Trumbull Film Effects, utilizing an application of the unique Slit-scan Process which Trumbull developed for the final "psychedelic" Star-gate sequence of Stanley Kubrick's "2001: A SPACE ODYSSEY", on which film he functioned as Special Effects Supervisor. Cover design, with its "rainbow waterfall" effect was generated from an outline version of the *CINEMATOGRAPHER* logo. (See Page 998)

AMERICAN CINEMATOGRAPHER, established 1920, in 50th year of publication, is published monthly in Hollywood by ASC Agency Inc., 1782 North Orange Drive, Hollywood, California 90028, U.S.A. **SUBSCRIPTIONS**: U.S. and Canada $6.00 a year; foreign, including Pan-American Union, $7.00 a year (remit International Money Order or other exchange payable in U.S.) **ADVERTISING**: rate card on request to Hollywood or New York office. **CHANGE OF ADDRESS**: notify Hollywood office promptly. Second-class postage paid at Los Angeles, California.

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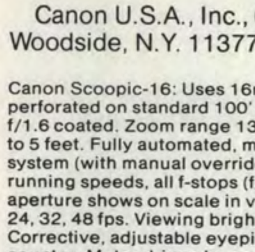
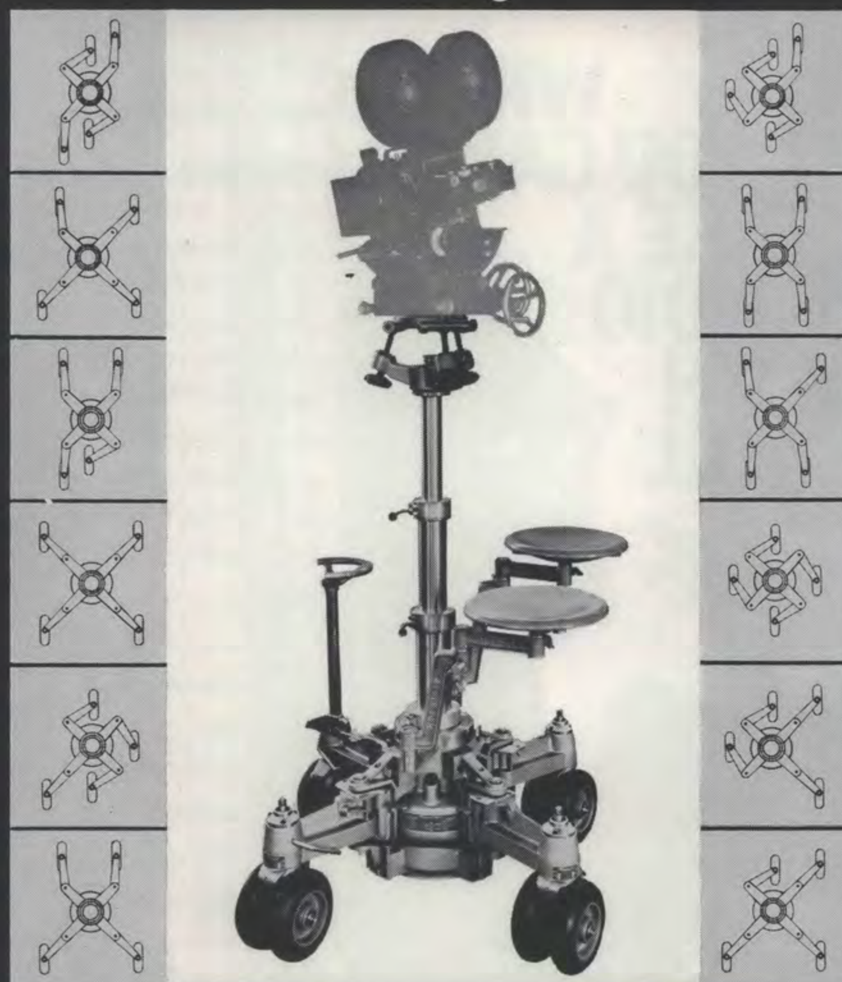


the spyder



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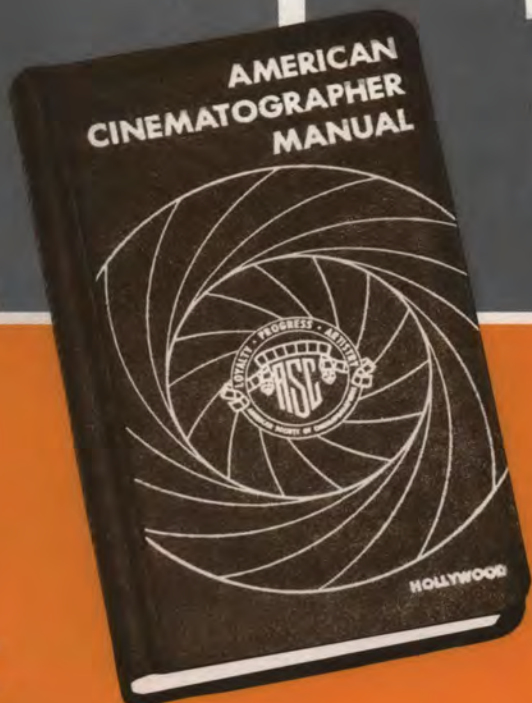

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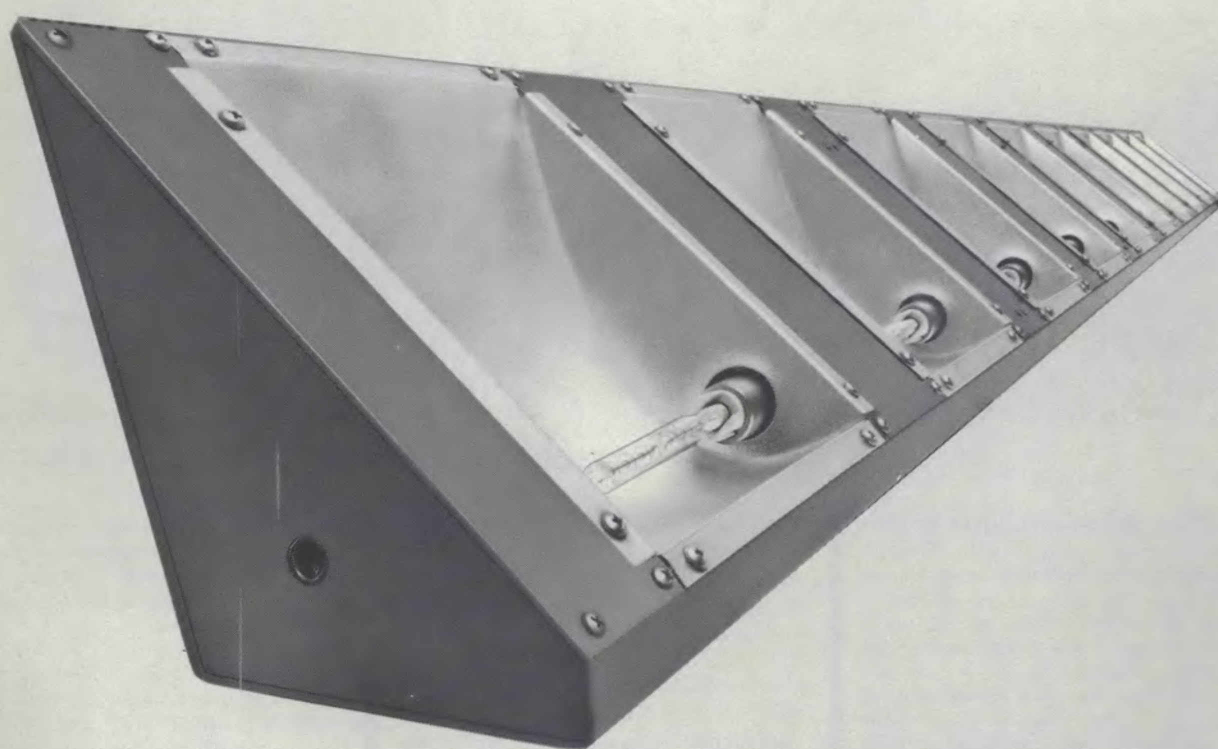

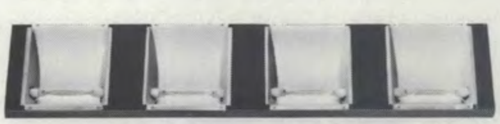

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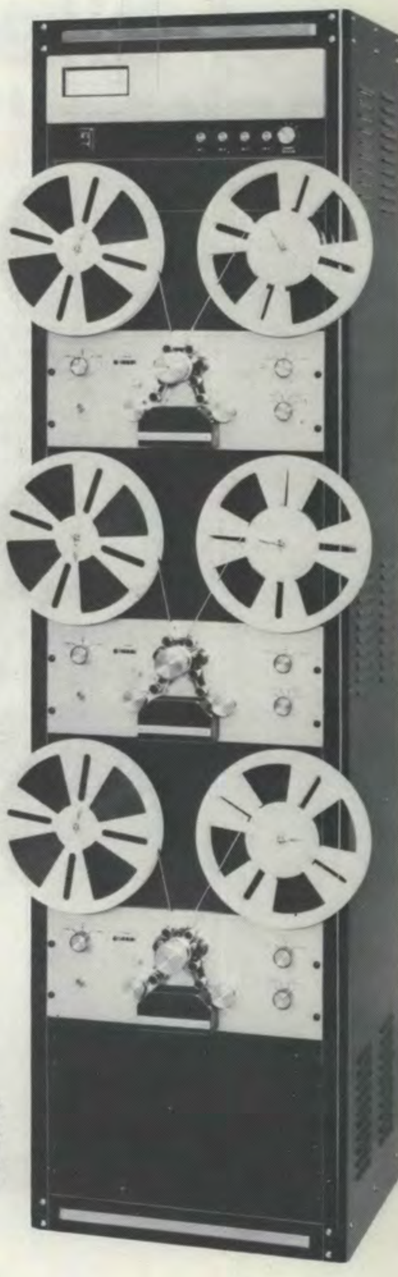

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If you are still making hundreds of loops for a single feature, then consider a fast, precise and economical method of altering sound tracks that makes "looping" obsolete.

The new Magna-Tech system electronically synchronizes a reel of picture with a reel of full-coat magnetic sound-recording film. Footage and frame "PRESETS" permit the recordist to select the scene to be "dubbed" and to fully control the advance and return of the film as the actor voices the line to be "dubbed."

The system is so accurate it will even permit the change of a single word without danger of erasing an adjacent word.

High speed return of the film to "start" saves time and permits new starts without waiting for a "loop" to complete its trip.

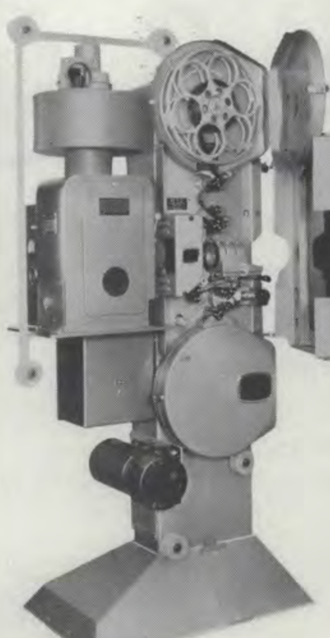
Actors, who so often succumb to the rhythm of a loop, are spared this hypnotic interference. Acceptable "takes" can be stored on the 3-track film and replayed for final selection.

A complete remote control system is provided the director so that, once the recording engineer has preset footages, the director can take over if he wishes and directly control every facet of the recording.

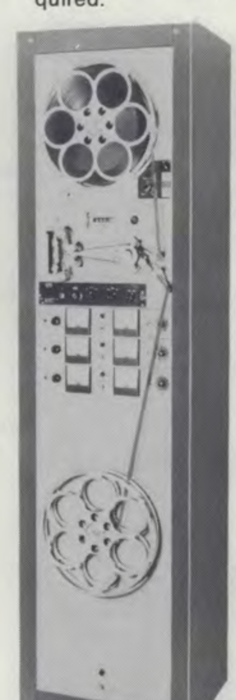
The Electronic Looping System precludes the need for cutting loops and eliminates the need for editing of the track. Complete reels of the motion picture are run in synchronization with the full-coat magnetic film on which the sound track is recorded. Transfer of the best takes is then made to the third track of the same recorder.

This track now has all of the final takes in sequential position and ultimately permits the screening of the picture and the final edited track in perfect synchronization. From this point the track is ready to go to a mix and no further editing is required.

Electronic Looping Console



35mm Projector



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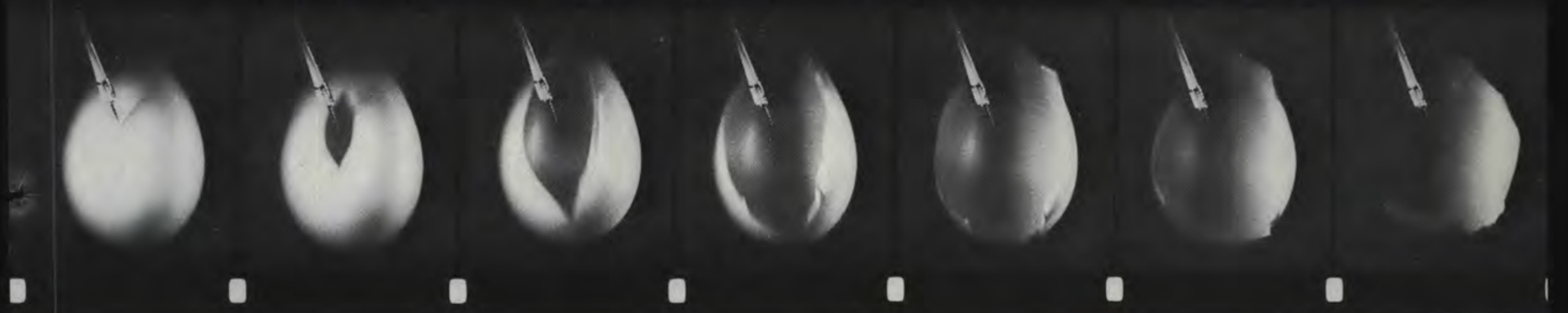
THE PROBLEM. THE SOLUTION.



The standard-speed motion picture sequence at the top illustrates the eye's inherent limitations in dealing with motion.

In the time it takes to blink an eye, the balloon just "disappears."

And that is the problem. We must understand, measure, evaluate, and correct machinery operating at velocities which are increasingly beyond our ability to observe directly.

The solution is a new engineering tool: a camera which extends our ability to perceive rapid motion, just as the microscope extends our perception of small objects.

The Red Lake high-speed rotating-prism camera reaches into high-velocity motion and captures it for detailed study.

The camera operates at variable speeds up to 44,000 pictures per second, providing an apparent speed reduction of 2000-to-1 when projected.

A shaft turning at 10,000 rpm appears at 5 rpm.

A computer end-gate swings open like a saloon door.

And between the third and fourth frames of the standard-speed movie, the rotating-prism camera takes 1,833 pictures. A slow, easily observable 125-second collapse, as shown in the edited lower sequence.

The only commercially-available camera with these capabilities is the Hycam, developed and manufactured by Red Lake Laboratories.

Hycam—and Red Lake's intermediate-speed cameras—are now standard tools of motion analysis. The first and most obvious step in trouble-shooting problems hidden by motion.

Further insights: Red Lake Laboratories, 2971 Corvin Drive, Santa Clara, California 95051.

RED LAKE

THE TROUBLESHOOTERS

9th International Congress on High-Speed Photography Denver, Colorado Aug. 2-7, 1970

ARRIFLEX 16's bring 'em back alive for Mutual of Omaha's "Wild Kingdom"

Imagine a three-foot long lizard that takes to its hind legs, and walks on water! Or another reptile with a third eye in its forehead. A bird that can regulate the time it takes to hatch its eggs. A fish that can live for days on dry land. Or a 16-ft. seal that adds 2 ft. to its length by simply inflating its nose! These are a very few of the thousands of fascinating and unusual creatures that have thrilled millions of TV viewers on NBC's unique series, Mutual of Omaha's "Wild Kingdom."

In producing the delightful programs that comprise the series, Don Meier of Don Meier Productions, Chicago, has found all the world's a stage—the Antarctic, the thick jungles of Africa and South America, the Australian Outback, mountaintops, deserts, rivers, streams, oceans—all play host to the intriguing creatures who are the "stars" of the eight year old series. The show has garnered no fewer than three Emmies and scores of other awards, but getting the kind of footage that draws such prizes is only half of Mr. Meier's problem—the other half is to reach the many inaccessible locations with production crew and equipment, to get back, and to do it all on TV's tight schedules.

Facing inflexible conditions like these, the producers choose Arriflex 16's to shoot almost all of the millions of feet that have gone into the series thus far.

Even the double-camera rig, developed by associate producer/cinematographer Warren Garst is lightweight and mobile with the Arriflex 16s cameras. This handy set-up takes full advantage of the Arriflex divergent turret; it permits the mounting of up to six telephoto, zoom and wide-angle lenses without physical or optical interference. By capturing the action on two cameras simultaneously, but with different optics, Mr. Garst is able to produce footage that intercuts as smoothly as if the animals had kindly repeated the action for a second take.

But it was most of all the out-of-the-way, inhospitable settings that demanded Arriflex. Shooting in temperature ranges from 10° below zero to 125° above . . . bouncing along over the roughest terrain, . . . sloshing through swamps, along rivers or out into the ocean . . . no TV series has ever subjected personnel and equipment to such a variety of grueling conditions.

In shooting everything from the creatures of the world to world-famous movie queens . . . productions intended to entertain the people, or to educate the practitioners in specialized fields . . . from sound stage to ocean floor, the adaptable Arriflex has made every setting into its natural habitat.

ARRIFLEX CORPORATION OF AMERICA Woodside, N. Y. 11377

Associate Producer and Chief Wildlife Photographer Warren Garst with Arriflexes mounted on double-camera rig he developed

Dave Marx (center) shoots jubilant L.A. Rams coach after win over Green Bay Packers.

Dave Marx shoots NFL Football games for NFL Films Inc. From the sideline.

With a 12 to 240 mm zoom lens. At 24 to 200 frames per second, mostly 200. Hand-held? Yes.

He uses an Eclair GV16. NFL Films Inc. owns 10 of them.

Dave Marx is the Director of Photography at NFL Films Inc. Each week during the season, NFL Films shoots eight National Football League games. From this footage, two half-hour TV shows are assembled; and they are then aired by syndicated TV stations nationwide as "NFL Game Of The Week" and "NFL Highlights."

At every game there's a GV16 on a tripod, up in the press box. There's also an Eclair NPR. Both cameras are covering the action at normal speed and using different focal lengths on their zoom lenses to give the editors both close-ups and long shots of the same action. What all the editors constantly demand, however, is super slow motion footage. So during crucial plays, the GV16 cameraman shoots at 200 frames per second.

Both cameramen have to know the game in order to anticipate the plays. It's easy to run out of film in the middle of *any* unrehearsed action, of course—and at 200 frames per second, you get only 80 seconds shooting from 400 feet of 16mm film! But that's not a problem for NFL Films. Why? Because both the NPR and the GV16 have 400 foot magazines that you can change in less than five seconds. And they accept both core wound film and daylight loading spools.

Dave Marx himself used to be a college football player. He covers a game each week from the sidelines, with a hand-held GV16 shooting mostly at 200 frames per second. Tripods aren't allowed down there, of course; and if they were, he wouldn't use one. As the play moves, so does he—at a run.

When a player throws the ball, Mr. Marx swish-pans to the receiver to see him faking the defense before the ball arrives. Then he switches from 200 to 24 frames per second for cutaway reaction shots of the players on the bench. Tripod heads just aren't that flexible; but you couldn't cover a whole game hand-held if the camera were either bulky or heavy. The GV16's body and motor weigh six pounds, and can be rested on your shoulder. The lens mounts on the front, the magazine on the back. Balanced. Overall, it's a pretty athletic camera.

For more information, write Eclair at 7262 Melrose Avenue, Los Angeles, Calif. 90046.

eclair

Camera makers since 1909

NEW THIRD EDITION OF AMERICAN CINEMATOGRAPHER MANUAL NOW AVAILABLE

The third and latest edition of the AMERICAN CINEMATOGRAPHER MANUAL, an official publication of the American Society of Cinematographers, has just rolled off the presses and is now ready for immediate distribution throughout the world.

The new manual has been compiled and edited by two veteran cinematographers, Arthur C. Miller, ASC, and Walter Strenge, ASC. It is the culmination of many months of work and represents the most comprehensive compilation of cinematographic data ever published.

The editors of the new manual are both experienced Hollywood cinematographers. Arthur Miller is the recipient of three Academy Awards for cinematography and has long been recognized as one of the industry's most distinguished Directors of Photography. Walter Strenge, a former United States Marine, has photographed scores of features and hundreds of films for television. Strenge is currently Director of Photography on the new ABC network television series, "Marcus Welby, M.D." starring Robert Young, which is being filmed at Universal City Studios. Between them, Miller and Strenge have a total of more than one hundred years of cumulative experience in motion picture photography.

Although the second edition of this popular reference book appeared only three years ago, rapid progress in the development of new cameras, films, lenses and related motion picture equipment and techniques within that period dictated the need for a completely new manual. It should also be mentioned that the second edition has been out of print for many months, so the new publication is long overdue.

In preparing the current manual, Miller and Strenge have had all charts, diagrams and special articles either completely re-written or up-dated in order to conform with current cinematographic practices. They have been assisted in this by members of the American Society of Cinematographers as well as by other experts in their respective fields. Manufacturers of professional motion picture films and equipment have also furnished extensive new data covering their products. *All material* has been checked and re-checked by these expert specialists to insure accuracy.

Tables, charts and calculations will always play an important part in the work of any professional cinematographer. The cinematographer must absorb a tremendous amount of data about lenses, filters, films, cameras and other types of cinematographic tools. Memories are not always reliable, and time for research and study is often limited. Therefore, an instant reference has al-

Continued on Page 1008

Co-editors Arthur C. Miller, ASC, and Walter Strenge, ASC, show a copy of the new AMERICAN CINEMATOGRAPHER MANUAL to Robert Young, star of the ABC TV network show, "Marcus Welby, M.D." at Universal City Studios. Strenge is director of photography on the series which made its debut during the current TV season.

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The APOLLO 11 Astronauts: Neil A. Armstrong, Col. Michael Collins and Col. Edwin E. Aldrin, Jr.

"THE EAGLE HAS LANDED!"

The epic achievement of men in space—and those on the ground—who, working together, scored a perfect landing on another World

". . . We copy you down, Eagle."

"Houston . . . Tranquility Base here . . . The Eagle has landed!"

For countless centuries, man had dreamed of this moment. The moment when men from the planet Earth would first set foot upon the long-mysterious moon. Now, in the sixth decade of the twentieth century A.D., the ancient dream had become a reality.

Even as Astronauts Neil Armstrong and Edwin A. Aldrin, Jr. landed softly in the Sea of Tranquility, preparations for a motion picture to commemorate this historic occasion were well underway. Although many films will depict man's first landing on the moon, the space agency would officially document the events in its own film.

In establishing the National Aeronautics and Space Administration in 1958, the Congress charged it with conducting research in aeronautics and space exploration, and with "disseminating the results . . . as widely as practicable."

Continued on Page 958

"That's one small step for Man... One giant leap for Mankind..."

This special "FILMING MAN IN SPACE" issue of *AMERICAN CINEMATOGRAPHER* is proudly dedicated to the courageous Apollo 11 astronauts, Neil A. Armstrong, Col. Edwin E. Aldrin, Jr., and Col. Michael Collins—and to all of the other brave astronauts, past and future, who, for the pride of America and the glory of All Mankind, are blazing a trail to the stars.

"THE EAGLE HAS LANDED"

Continued from Page 956

NASA's Office of Public Affairs conducts a number of varied programs as methods of informing public audiences and of explaining the results of its activities to them. These programs include news releases, publications, exhibits, educational services, television and radio programs and motion pictures.

During the past ten years, NASA has released well over 100 films for free-loan use by television networks and stations, schools, civic and professional organizations and other public groups, both in America and abroad. Most of these films were produced by commercial or educational film producers, under contract and supervision from NASA. Some—usually all-stock-footage productions—were produced by NASA staff personnel.

NASA cameras have provided millions of feet of documentation and engineering footage, a valuable "spin-off" benefit of the wide-ranging research and development activities of the agency and its contractors. If tests or training functions go wrong, such film can provide a valuable aid to the reason for failure and what must be done to correct it.

NASA depositories near Washington and at several of the agency's major research centers contain more than twelve million feet of 16mm color footage, limited amounts of 35mm and 65mm footage, thousands of color transparencies and black-and-white photographs, and miles of sound track audio tape and video tape.

Only a small percentage of this material can be used in films, TV and radio series, and school materials which are "packaged" for release by NASA. The agency has a liberal policy, however, of cooperation with other producers who wish to utilize these and other NASA resource materials in their own informational, educational and industrial films.

With agency approval, producers can purchase suitable stock footage from contractor-operated laboratories, for space-related films ranging from Super 8mm home movies to 70mm feature producers. NASA believes that such a policy helps other filmmakers in a broader interpretation of the space age.

In addition to a limited number of films intended primarily for public audiences, the agency also produces film reports for training and management purposes. Many of these more technical films are also made available for secondary and college audiences and the scientific community. The current NASA Film List for general audiences includes about 100 titles.

The space agency attempts to be innovative in its public release films, seeking techniques of presentation which will make the viewer feel he is an eye witness participant in the events. Although the technical details of Apollo missions are often similar and repetitive, NASA seeks a distinct style for each new film.

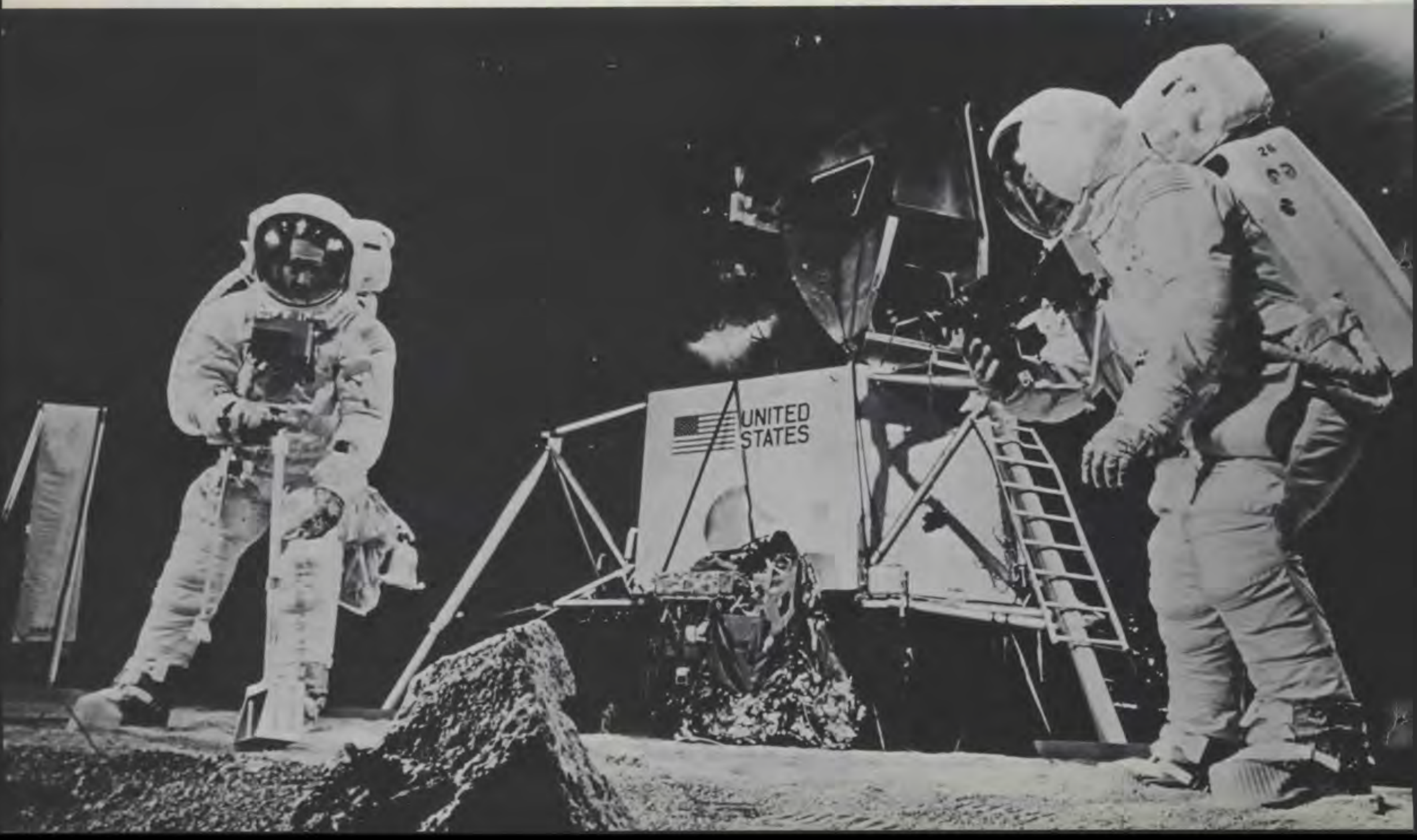
Before the Apollo 11 mission took men to a lunar landing, NASA's audio-visual staff had dealt with the series of Mercury and Gemini missions in film productions. But as the Apollo flights took man closer and closer to the Moon, public requests for NASA films on each mission increased.

The Apollo 8 Christmas-time mission to the Moon was presented on film with interpretative comments by leading Americans from many fields. The Apollo 9 flight to test the lunar module in earth orbit was shown as a pictorial space-ballet and was cut to the orchestral score from the Beatles' film, "The Yellow Submarine".

Apollo 10 took men within 60 miles of the lunar surface, and was presented in a NASA film as a chronological, suspenseful drama.

Apollo 11 was unique. For the first time, men would land on the Moon. Regardless of what took place in the years ahead, this space flight would stand as man's first encounter with another world.

Rehearsal for a date with Destiny: During simulation exercises Neil Armstrong and "Buzz" Aldrin practiced setting up the various scientific experiments which kept them so busy when they actually made the first landing of Man on the Moon.



By the time the crew returned home, nearly a billion people in most of the world would have witnessed the exciting events through television and communication satellites. There would be network documentaries, educational films, home movies and other film interpretations following. But requests for a NASA film were already coming in.

Since the picture would be produced entirely from stock footage and color stills, and since there was great pressure to have prints in distribution as soon as possible, NASA staff decided to make this film themselves.

Before Apollo 10 lifted off the launch pad, planning meetings on the Apollo 11 film were being held. Background footage on training, hardware assembly, testing, the "roll-out" of the Saturn V-Apollo to the launch site—all were reviewed and selection for masters was made. But most of the final picture must await the return of the astronauts with their priceless first-time pictures.

July 16: The Apollo 11 lifted off the pad at the Kennedy Space Center. The event was recorded from many angles, including engineering cameras merely feet from the rocket, housed in special shock-proof coverings. En route to the moon, a television camera was used by the crew to send back color pictures of some of their activities. July 20: Apollo 11 reached the moon and lunar module "Eagle" separated from the command module "Columbia" and descended to the surface. On-board film cameras covered most of this activity with remarkable clarity, including the breath-taking moment of touchdown.

On the lunar surface, the astronauts would be busy with programmed activities: the collection of rock and soil samples, placement of scientific apparatus and commemorative artifacts, tests of locomotion, and so forth. They also took motion pictures and still photographs.

After two and a half hours, the moon voyagers had to re-enter their spacecraft, rest and prepare for the rendezvous. En route home, there would be more photography.

July 24: Shortly after dawn over the Pacific Ocean, the fiery ball of the Apollo spacecraft was seen streaking back into the earth's atmosphere—recorded for the first time by a camera.

The men were home. Anxious hours and days would follow. While Astronauts Armstrong, Aldrin and Collins remained in isolation for examinations and briefings, and technicians and scientists began a careful examination of the moon-matter they had brought back, the NASA film staff began to shape up their film production.

After a brief delay, the on-board 16mm footage and the 70mm still photographs were carefully processed in laboratories at the NASA Manned Spacecraft Center. Soon, masters of this material were on their way to Washington for the NASA film; portions were being released as available to the news media; and composite stock rolls of mission highlights were being prepared for use by other producers.

Around the clock, the visual material now poured into the NASA Headquarters Depository. Launch footage from Kennedy; on-board footage and stills from Houston; recovery footage from the Pacific landing site; video tape-to-film transfers from labs in California and Virginia.

For the members of the NASA Headquarters motion pictures staff, editorial and technical personnel of the contractor laboratory in Washington, and a consultant producer-designer, the next several days were almost one unending day. The new material was excellent and most of it could be used.

Work print—music—rough-cut—voice-tracks—effects—titles—editing—mixing—screenings—transfers—final mix—answer print. The picture shaped up.

The film would concentrate on activities on the lunar surface, but most of them had been shot with an engineering camera at one-frame per second and could not be used immediately. Still photographs were chosen and filmed on an animation stand. Pre-landing footage had to be pared down, intercut with scenes of man on the Moon. Footage on some of the Lunar Receiving Lab experiments did not arrive, so alternate decisions were made. There was not enough commentary by the astronauts themselves, so work was held up until the end of the isolation and the televised press-conference.

Finally, on August 15, the film was completed. Within a few hours, the printing machines were humming and release prints were being shipped to TV stations, NASA libraries, and awaiting audiences.

"Eagle Has Landed: the Flight of Apollo 11" will be widely seen. It was designed as a visual experience through which each viewer might share some of the feelings of the men who made this epic journey to the Moon and the varied earth-bound people who helped them prepare for it. The 28-minute production has been televised by several hundred commercial and educational TV stations, seen already by many organizations throughout the country.

A narrative sound track has been prepared for later prints which will be available to school children and teachers. Prints of the film are being sold for noncommercial use by the new National Audiovisual Center, National Archives and Records Services, Washington, D. C. The U. S. Information Agency has distributed the film abroad with narration in more than a score of languages. A government committee has selected the film for entry in several overseas film festivals.

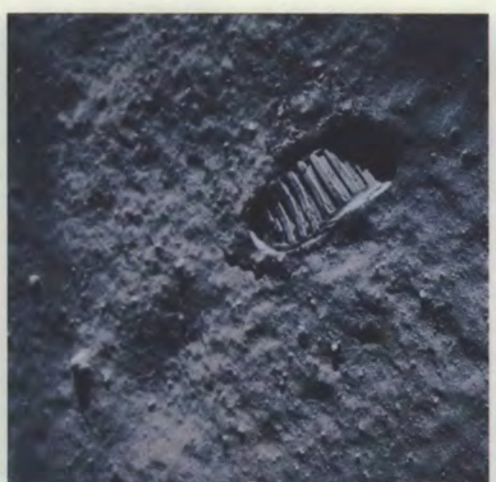
"Eagle Has Landed" was produced by Clayton Edwards, NASA, designed and directed by Ted Lowry. Associate producer was Lynn Moore, NASA. Bastian Wimmer was the editor, and editorial services were provided by Byron Motion Pictures, Inc. of Washington. The narrator for the revised version is John Flynn, and the script is by Walt Whitaker, NASA. Original music in the film was composed and conducted for earlier NASA films by Bernardo Segal.

The mission is over, and NASA scientists are working on future manned and unmanned space missions. The Apollo 11 film is completed, and the NASA film personnel are busy with other films. Hopefully, the next film can be done at a more leisurely pace. ■









DOCUMENTING MAN'S WALK ON THE MOON

The Photographic Technology Laboratory at NASA's Manned Spacecraft Center faced a unique challenge—that of documenting on film for posterity sights in the Universe never before seen by the eye of Man

By JOHN HOLLAND, JR.
Head, Technical Laboratory Branch
and ANDREW M. SEA III
Chief, Audiovisual Branch
Photographic Technology Laboratory
National Aeronautics and Space Administration

On July 20, 1969, 1700 feet of the most dramatic motion picture film in the history of man was exposed on the surface of the moon. Its drama, of course, lay in the fact of where it was exposed, rather than its artistic achievement. Even so, this film footage, shot by two amateur cinematographers, is destined to become the most famous in history.

Actually, the 1700 feet of 16mm color film exposed on the lunar surface in the form of motion pictures was just part of the photographic mission to be handled by Astronauts Neil Armstrong and Edwin Aldrin.

The Apollo 11 crew was equipped with three camera systems. The motion picture system—a specially-built, electronically-controlled, variable frame rate 16mm camera—was designed to operate both as a bracket-mounted automatic unit during the lunar landing approach, and as a hand-held unit during the lunar excursion phase of the operation. This camera system, used on all the Apollo flights to the lunar area, can be operated at frame rates of from 1-to-24 frames per second to accomplish specific tasks.

The motion picture camera was backed up by a still camera system modified to accept 70mm motion picture film in 35-foot rolls. A third camera system was added to the Apollo 11 complement to make detailed photos of the lunar surface. This unit, a 35mm stereo close-up camera developed by the Eastman Kodak Company, was used to produce 17 photos showing the three-dimensional details of selected lunar features.

Films selected for use on the historic Apollo 11 mission were Kodak Ektachrome EF film SO-168 (ASA 160), in 16mm and 70mm; Kodak Ektachrome MS film SO-368 (ASA 64) in 16mm, 35mm, and 70mm; and 70mm Kodak Panatomic-X recording film SO-164. All films used were fabricated on Kodak's Estar thin base which has a 2½-mil film thickness, as compared to the standard 5-to-7 mil thickness. This reduced thickness allows up to 33 percent more film to be carried on weight and bulk-critical space missions.

Several considerations determined the selection of the relatively low speed color films employed on the lunar landing mission. Previous Apollo flights in the lunar area, for example, had recorded specific radiation levels. Our studies of the radiation effect on film—conducted here at the Manned Spacecraft Center and other locations, including Kodak's Rochester facility—had indicated that high film speeds accentuated the fogging effect created by exposure to radiation. This, in conjunction with the relatively high light level on the daylight surface of the moon, indicated that the Kodak Ektachrome MS color film, with an ASA index of 64 would be the best choice for the lunar filming. Coincidentally, and indicative of the uncertainties of space travel, the Astronauts of Apollo 11 encountered significantly less radiation on the lunar surface than previous Apollo fly-bys of the area had recorded.

Color photographs on the opposite page of the Apollo 11 lunar flight and moon-walk were exposed in deep space by Astronauts Neil Armstrong, Michael Collins and Edwin Aldrin. Needing no captions, they are presented simply as a "gallery" of photographic Space Art.

Kodak Ektachrome EF SO-168 was selected for use within the Lunar Excursion Module (LEM) to cope with the lower light levels encountered there.

All films used on the Apollo 11 flight were coated on the Estar thin base at Eastman Kodak in Rochester, New York. Prior to flight time, a NASA aircraft flew to Rochester to pick up the special film batch and fly it to Cape Kennedy, where it was stored under refrigeration.

Similar caution and special preparation were taken at MSC-Houston, where the lunar films were to be processed in the Technical Laboratory Branch facility. Several weeks prior to the lunar flight, all processing equipment in the lab was completely stripped and refurbished. A number of pre-flight simulations were run to check both equipment and chemistry. Then, to be absolutely sure that no mistake would endanger the one-of-a-kind film to be brought back from the moon, Kodak experts in each of our processing fields were called in to recheck our own preparations.

When the historic film was delivered to our laboratory, all was in readiness. The 16-35-70mm Ektachrome SO-368 color film exposed on the moon—a total of 785 feet—was placed in the High Speed Equipment Company processor using the Kodak ME-2A 75° chemistry. This unit, extensively modified by NASA, essentially is two machines employing a single set of chemical tanks. It is capable of processing 16mm and 35-70mm film footage simultaneously or separately at a rate of 35 feet per minute.

The 16mm Ektachrome SO-168 motion picture film returned from the moon was processed by a similar piece of equipment using the Kodak ME-4 elevated temperature chemistry, at a rate of 90-100 feet per minute.

Within minutes a deep sigh of relief echoed through the laboratory. The processed camera stock emerging from the processors was good.

The processed film was printed quickly for release to news media. Then, we settled down to producing corrected color prints.

Using an Acme Optical Printer equipped with an additive color head and punched tape control, we expose Eastman Ektachrome Release Print Film, Type 7388, for all 16mm release prints. The flexibility and color quality of this material gives us the needed leeway to compensate in printing for variables introduced in exposure.

While Astronauts Armstrong and Aldrin, for example, have been trained in photography, neither can be classed as a professional cinematographer. Under the stress of what must have been the most exciting event of their lives, they made small mistakes in exposure. Similarly, the technology of the camera systems creates printing problems. The 16mm motion picture camera's variable frame rate must be compensated for in printing. And, when employed within the spacecraft, this camera system is bracket-mounted to shoot through a mirror, resulting in a flopped image on the camera stock.

After months of preparation, precaution, and even finger-crossing, the big day came and went without special incident. Our equipment and personnel did their jobs without a hitch. The historic lunar landing films were processed and printed and released.

Yet, important as the film footage from the moon was, it constituted only a very small part of the motion picture work being done at the Photographic Technology Laboratory.

The Photographic Technology Laboratory at MSC-Houston is headed by John Brinkmann, who has overall responsibility for both film production and processing. The Audio-visual Branch of the Laboratory is responsible for film production, as well as maintenance of the NASA motion picture film library, film distribution and broadcast services.

Audio-visual's 47 people—seven civil service personnel in the management group, with 40 staff contractors supplied through the A-V Corporation, Houston—produced 31,000 feet of silent film and over 7,000 feet of synchronous sound film, all in 16mm color, in the month of July, for example. Four sound-color films, totalling 82 minutes of stock, reached the answer print stage of production, while two other films were completed through interlock. These films were in addition to the footage produced in connection with the flight of Apollo 11.

In addition, Audio-visual received, and catalogued 73,736 feet of 16mm color film from suppliers and contractors connected with the Apollo program, incorporating it into the Stock Film Library. Under NASA contracts, suppliers must document all stages of design and fabrication of space mission components on 16mm Kodak Ektachrome Commercial film exposed and processed to space agency specifications. This material is retained in the Stock Film Library for use in preparation of technical support film reports, training films, film clips for public relations uses, congressional reports and mission films. In all, Audio-visual produces 800 to 900 minutes of documentary films each year, ranging from 7-to-10-minute Astronaut profiles for release to news media, to 15-minute quarterly reports for the Office of Manned Space Flight in Washington, to 30-to-40-minute progress reports on all work in progress at the Manned Spacecraft Center.

The Technical Laboratory Branch at MSC has 13 civil service management personnel and operates with a 60-man contract staff to handle all photographic quality control, and still and motion picture processing. An average of about 1,000,000 feet of camera and print stock per month is run through the Branch's processors, with the bulk in print stock to meet the distribution needs of the Audio-visual Branch. About 95 percent of the motion picture film processed is 16mm color stock, with the remaining five percent consisting of 70mm (about four percent) and 35mm (very little).

While the Technical Laboratory Branch was directly concerned with handling of the lunar landing films, the Audio-visual Branch now takes over. Segments of the motion picture film exposed on the moon will be incorporated with stock footage from various phases of mission preparation and with new footage to be produced at MSC to create a variety of reports.

Astronauts Neil Armstrong and "Buzz" Aldrin were part of the NASA photographic team during their walk on the moon. They were the location camera crew. The American space effort and the moon itself were the "stars." ■

(LEFT) Motion picture processing area of the Photographic Technology Laboratory at Houston's Manned Spacecraft Center. Serviced by seven civil service personnel in the management group, plus 40 staff contractors supplied by the A-V Corporation, the lab produces a prodigious amount of film in addition to that from the Apollo flights. (RIGHT) Inspection and microphotography of film. Sensitometer at left, densitometer at right.

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APOLLO 11 PHOTOGRAPHS

How the world's most famous photographs were accorded precision processing after an elaborate de-contamination procedure

"I'm waiting for the world's most famous courier," quipped Richard Underwood, Chief of the Precision Photographic Laboratory at the Manned Space Center in Houston, as he described the procedure the precious photographs from Apollo 11 would follow in getting from the moon to the anxiously awaiting world press.

Underwood was, of course, referring to the Apollo 11 craft's crew bringing nine Hasselblad camera film magazines who described them as "stacked to the ceiling."

The magazines, exposed with three Hasselblad EL/70 cameras by the Astronauts and protected in plastic, were taken from the spacecraft and immediately put into another set of sealed plastic bags. The plastic bags were then given a sterilizing bath for 15 minutes in a solution of 5000 parts per million of sodium hypochlorite. The film load was then split and flown in two separate

The interleaving allowed the decontaminating gases to circulate throughout the roll of film. An 18% ethylene oxide (dichloro-difloromethene) mixture was used in an Autoclave at 78° F together with 28 inches of mercury. Thirty inches of mercury is a perfect vacuum for 16 hours.

Following this was a test of the decontamination: bacilli were introduced into the spools and incubated for 24 hours in a nutrient. Their survival

(LEFT) Solutions are carefully prepared in the mixing room by Terry Slezak, who inadvertantly became the first man on earth to touch moon dust while removing magazines for identification from the specially sealed plastic containers used by Neil Armstrong while he was on the moon. (RIGHT) Manned Space Center Precision Photographic Laboratory technician checks film at finishing end of Versamat film processor.

back to the Center's lab for processing. Possible contamination from the moon extended the film-handling procedure considerably, as he then detailed.

Attention shifted abruptly to the photographic laboratory as soon as safe recovery of the returning moon visitors was apparent. The lab is responsible for special handling of film and interpretation of still photographs as well as processing.

The still photographs Armstrong and Aldrin took documenting their historic epic journey assume an equal significance, justifying the eagerness with which they were awaited. Requests for the first release of black and white and color photographs were unestimable, according to Ann Bownds of the Still Photo Press Library at the spacecenter aircraft like their precious co-load, the moon surface samples.

After their arrival at the Lunar Receiving Lab, the bags were opened and the magazines reviewed for processing priority. The magazines chosen for the first batch went into the darkroom and the film removed from the magazines on their spools.

Up to this point, the procedure, except for the sealed plastic bags in which they traveled, has been the same as it has been for the approximately 7,500 Hasselblad still photographs brought back by astronauts from Mercury through Apollo flights. But the next step in the darkroom was especially for this flight's film: it was a re-spooling of the film with an interleaving of a polyester material.

would indicate a failure of the decontamination process. The strain of bacillus chosen for the test is strong enough to survive lunar environment.

After this last step, which tested favorably in the dry run time and again, practically assuring positive results, normal processing could begin.

But which rolls should be processed? With nine magazines of over fourteen hundred frames to choose from with only eight at the most to be released at first, careful consideration was given this question. The subjects of each magazine was reviewed and the selection finally made by administrative and public affairs officials.

The Hasselblad photographs taken on the moon in the film magazine coded S were especially valuable. Not only were they the first of this incredible feat, but the camera was outfitted with a special Zeiss Biogon 60mm lens and a Reseau plate for precise measuring of areas photographed. The grid marks show up as crosses along the edges of the 2¼-inch square photographs.

Since magazine S contained what were, at that moment, probably the 127 most important photographs in the world, NASA wisely refused to let these precious frames go through in the first batch of the decontamination process, despite the fact that the world press was eagerly awaiting them. If something had gone wrong, they didn't want that particular roll of film damaged.

Ironically, it was in the handling of that precious magazine S film that the photographic industry achieved the dubious distinction of having the first man to touch lunar soil—with his bare hands, that is. As he reached into the sealed plastic bag for the exposed Hasselblad film magazine, Terry Slezak, photo lab technician, got more than he expected, including instant fame.

At the moment he was contaminated, Terry was performing the first step on the long road to eventual printing, that of identifying the coded magazines and reviewing their contents. In this way, NASA officials were able to give a priority to the magazines for processing.

Inside the sealed plastic bag was a note from Neil Armstrong explaining that this was a very important magazine, the one exposed on the lunar surface, and that it had been dropped by him. After retrieving it, Armstrong put it into its protective plastic, moondust and all.

Whether history will consider Slezak to be a hero (or simply not too bright) for having handled a "moon magazine" without wearing suitable protective gloves, remains to be seen.

The special camera which exposed the famous magazine S, designated the Hasselblad Data Camera by NASA, differed from the two used on the Command Module and the LM which were the standard versions of the electric Hasselblads that have flown since Apollo 8. The camera that remained aboard the Command Module for use by Astronaut Collins was equipped with two interchangeable Zeiss lenses, the Planar 80mm and Sonnar 250mm. Collins employed this camera to shoot the exciting return link-up with the LM plus some outstanding earth shots, and switched to a 250mm lens for some excellent lunar surface photographs.

Armstrong and Aldrin had a standard Apollo Hasselblad anodized in black to use inside the LM, and the special "silver" one for the EVA. Their prime instruction once down safely, was to photograph everything they could from the LM just in case they had to take-off without performing the EVA. All other activities on the lunar surface were photographed producing the spectaculars printed in every major national and international publication, including this special "Filming Man in Space" issue of AMERICAN CINEMATOGRAPHER.

As a precaution, together with magazine S, there were included in the second batch to be processed one additional color and three black and white rolls. The first batch included magazine R which Aldrin exposed from the LM, plus one more color and three black and white rolls.

After more deliberation of the processed rolls, the chosen frames were then printed and distributed which, on Apollo 11, kept the processing lab working at full capacity for 24 hours a day.

Apparently none the worse from his experience, Slezak demonstrates how he became "contaminated" by magazine dropped on the lunar surface by Armstrong.

The first groups of photographs were delivered to the press in record time. They were from the magazine exposed inside the LM. An additional four photographs were released the next day from that same group of four magazines initially processed.

Underwood and his group accomplished their monumental task with such expediency the surprised press found themselves with a new batch of photographs about every 24 hours. A press conference called to calm the clamor from the press for pictures, indicated a much slower pace.

The accelerated release of photographs was due to the tremendous push by the lab team to work as long and efficiently as is humanly possible, in all systems working smoothly, and in farming out part of the printing. (Private printing facilities in the area were saturated and still the demand exceeded the supply.)

Continued on Page 1007

(LEFT) Geologist Herb Tiedemann studies photographs of Earth's surface made during Gemini flights. (CENTER) Lab Chief Richard Underwood (standing) works with astronauts Collins, Stafford and Borman as they compare film strips from Gemini flights. (RIGHT) Precision Photographic Laboratory specialist checks film sensitometry by means of a densitometer.

LIFT-OFF AT CAPE KENNEDY

A record number of Technicolor camera crews trained their lenses on what history would call "Man's boldest thrust into the future"

The role of Technicolor, Inc. in "FILMING MAN IN SPACE" goes back to 1964, during the early days of the Gemini flights. Having, since then, become an integral part of the U.S. space program, the company's role was given increased importance on January 1, 1969 when Technicolor became the prime contractor for all photo support, not only for NASA, but for the Air Force, Army and Navy operations within the Cape Kennedy region.

In July, Technicolor assumed new contractual responsibilities with NASA and the Air Force to function as sole producer and processor of motion picture and still photos at Cape Kennedy Air Force Station and Kennedy Space Center, Florida.

Apollo 11, riding the nose of a mighty Saturn V rocket, roars skyward in a blast of smoke and flame from its pad at Cape Kennedy to keep a date with Destiny on an alien world of "magnificent desolation".

When the historic flight of Apollo 11 to the moon lifted off from Kennedy Space Center on July 16, Technicolor, Inc. employed a record number of more than 200 still and motion picture cameras and a staff of 263 people—including 48 cameramen—to provide photographic coverage of the event for the National Aeronautics and Space Administration.

Under the direction of Robert Forster, project manager for Technicolor's Florida operations, the intensive photo support for Apollo 11 included 16mm, 35mm and 65mm color motion picture coverage, as well as 35mm, 2¼ x 2¼, 4 x 5 and 70mm still picture documentation.

Functioning in its capacity as sole producer and processor of motion picture and still pictures at Kennedy Space Center, as well as at the Air Force Eastern Test Range, Technicolor provided rush processing at nearby modern laboratories—still photos being finished by its lab in the headquarters building at Kennedy Space Center, while motion pictures were processed by the Technicolor-operated facility at Patrick Air Force Base.

For coverage of the launch of Apollo 11, Technicolor crews positioned about 150 cameras on and about Pad 39, the site from which the 363-foot Saturn rocket lifted off with its three-man crew en route to the moon. Most cameras on the launch tower and adjacent to the pad were started by an automatic sequencer within the Launch Control Center, located about three miles from the actual launch site.

At lift-off, Technicolor operators also manned the telescopic tracking cameras, situated at remote locations on Cape Kennedy and ranging along the Florida coast north from New Smyrna Beach to Vero Beach on the south. These cameras not only filmed the Apollo in its early stages of flight, but also fed live TV "pool coverage" to all

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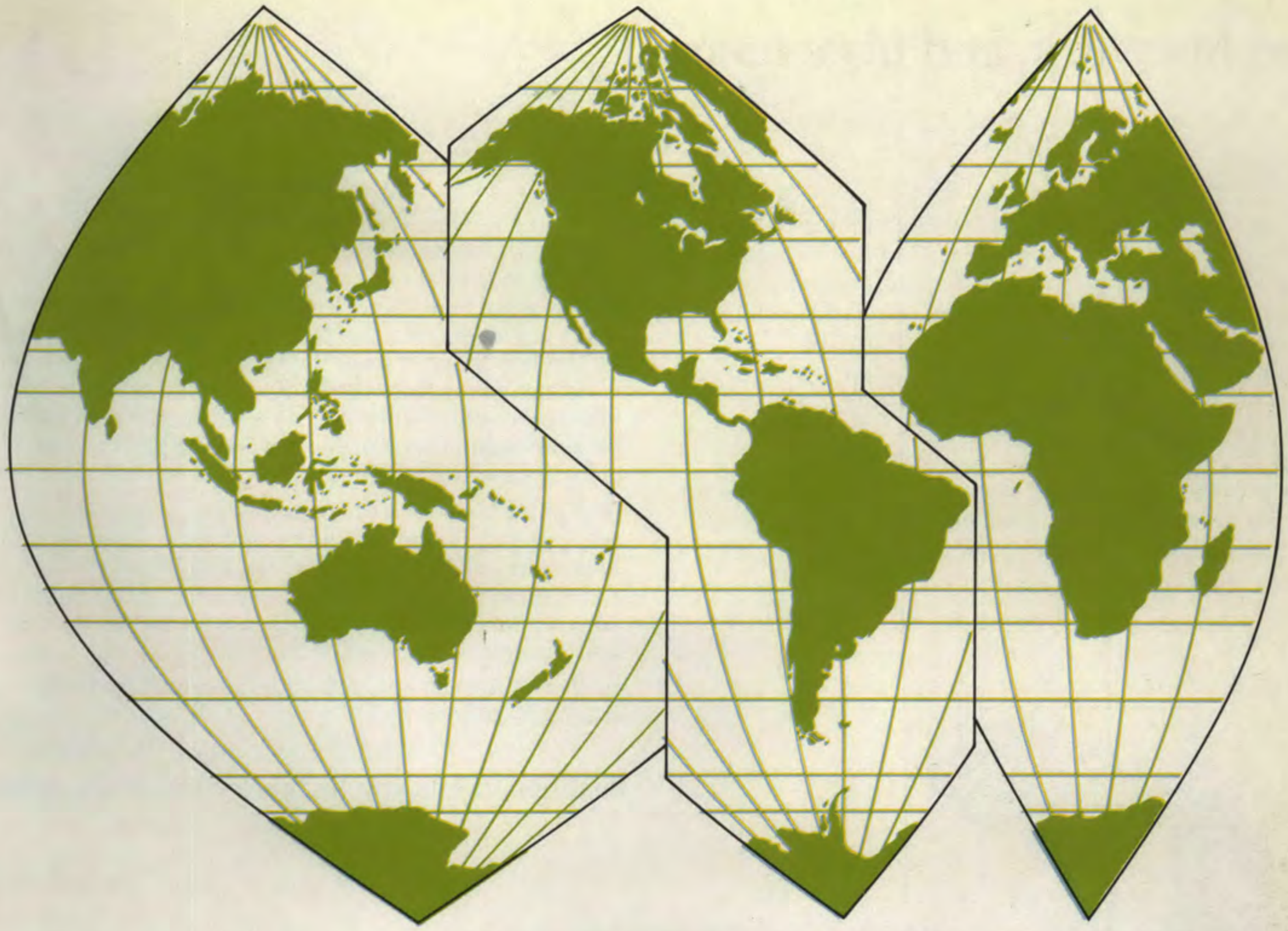

A man, his work, and his camera

Baldwin Baker Jr. —Director, Writer, Cinematographer.

"Not long ago, I shot some western footage in Jackson Hole, Wyoming.

Because my 16mm Beaulieu is so mobile, I was able to capture some marvelous flavor. It's a personal kind of thing. I like to hold my camera as close as I can. Actually I almost cradle it. In fact, I saw a copy of a letter from someone at MGM in New York. He said, 'Trying to shake hands with Baker is a real experience. You reach for his hand, and you shake his camera instead.'

One of my most recent experiences with my Beaulieu was the film I did with Stan Kenton and his orchestra on the road.

I travelled over 3,000 miles with the band on the bus, and my Beaulieu was always in my lap or at my eye. That's what's great about the Beaulieu. It's so small and light, it's like an extension of my arm. Anyway, what I wanted to do with the Kenton thing was to take the viewer right into the bus; to show him what a series of one night stands were really like. By the way, the name of the film —it's a TV special—is "Bound to be Heard." For the on the bus flavor, I used the Beaulieu with an extreme wide angle lens from the back seat. In that series of shots, you'd swear you were there. I used an Eclair for all the lip sync sequences, but for the feeling, for the real color, I used the Beaulieu.

One important thing of course, is that you have to be ready to grab everything the first time around, so it doesn't look restaged. You know, like the Hindenburg only came down once. In the Kenton picture, 90% of it unfolds just the way it happened. In a thing like that, I feel as though you're capturing a moment in time.

And, as a film-maker, you had damn well better be there when it's happening."

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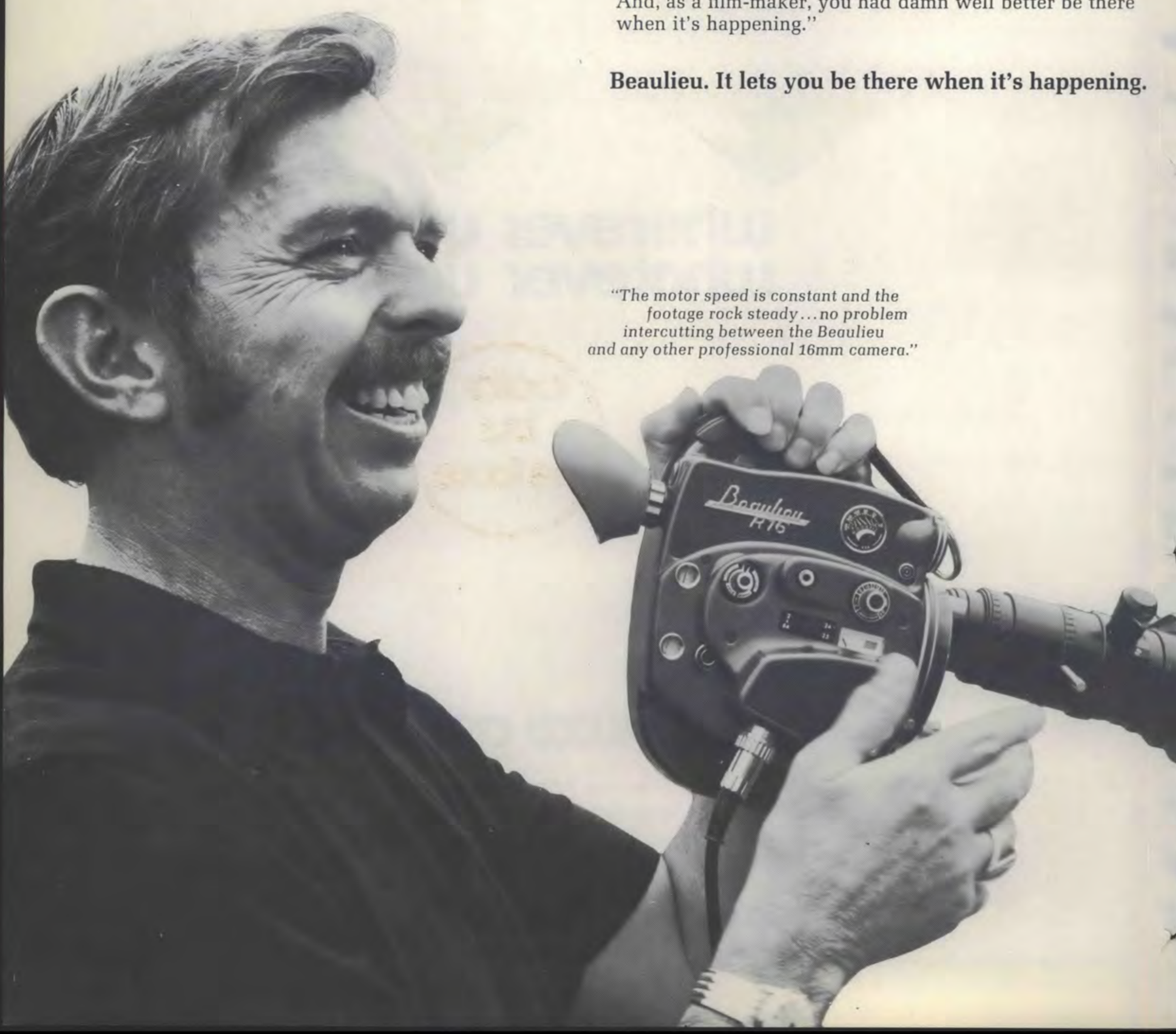

"The motor speed is constant and the footage rock steady... no problem intercutting between the Beaulieu and any other professional 16mm camera."

"Reloading the Beaulieu R16B becomes a very, very fast operation once you get the feel of it... the next thing to automatic loading."

"The brightness through the Beaulieu's reflex view finder is almost unbelievable. And since the mirrored shutter ***always*** *stops closed, I'm usually ready to shoot faster than anyone else."*

"In a cherrypicker, high up a mast, in a helicopter... the Beaulieu is easily adaptable to difficult shooting conditions without assistance, rigging or time consuming planning. I prefer the Beaulieu to any other camera for my aerial work."

"...impressed by the automatic iris control, liked the way it corrects for exposure as you pan. It doesn't seem to be obvious...very subtle..."

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FILMING MAROONED

In the wake of Apollo 11, a science-almost-fact movie that is nearly as real as the real thing

By HERB A. LIGHTMAN

While Neil Armstrong and Buzz Aldrin were gamboling about the surface of the moon like a couple of frisky colts, post-production work was being completed on "MAROONED", a fictional (but not *very*) roadshow feature production about men in space which takes up just about where Apollo 11 leaves off. ■ Produced by Mike Frankovich and directed by John Sturges for presentation by Columbia Pictures, the film deals mainly with a problem that is currently engrossing some of the best technical minds in America—that of finding a way to rescue astronauts stranded in space. ■ Selected as Director of Photography for the challenging assignment was ace cameraman Daniel Fapp, ASC, winner of the 1961 Academy Award in color cinematography for his stunning photography of "WEST SIDE STORY". ■ Several lengthy sequences of "MAROONED" take place inside an Apollo space capsule and, for the sake of authenticity the one used in the film was built in Texas by some of the people charged with constructing the real thing. Not being film-wise, they structured the spacecraft all in one piece, just like an actual capsule. This constituted an impossible lighting challenge, so ways and means had to be found at Columbia Studios to cut the craft into pieces so that "wild" sections could be removed to

(LEFT) Astronauts float weightless inside Space Lab while they go about their operational duties. (BELOW LEFT) Astronaut Richard Crenna emerges from the capsule to try locating source of the trouble that prevents retrofire engine from functioning. (BELOW RIGHT) Director of Photography Daniel Fapp, ASC, gets down on the ground to line up a "worm's-eye-view" camera angle, as his crew looks on.

(TOP LEFT) Microphone boom and lights are moved into position on the sound stage to shoot scene of space capsule exterior. (TOP RIGHT) Director John Sturges and Gregory Peck relax between set-ups. (BOTTOM LEFT) Cameras, cranes and rolling stock are positioned for location filming at Cape Kennedy. (BOTTOM RIGHT) Apollo command module and Space Lab jockey into position for link-up.



(LEFT) Space capsule built to authentic specifications had to be cut apart to permit lighting, which included boring holes through floor and ceiling. Even so, lighting and angle changes were limited. (CENTER) Astronaut emerges from Apollo capsule to discover cause of retrofire engine failure that has left them marooned in space. (RIGHT) On set that is exact replica of Mission Control Center at Houston, officials give order for lift-off of Rescue Vehicle X-RV.




accomodate lights and the camera. Even so, there was a definite limit to the variety of lighting and angles that could be achieved.

"It was necessary to cut holes in the floor and ceiling of the capsule so that we could beam some light inside," recalls Fapp. "We had to stay with small lights, like Baby Juniors, because of the tight quarters and there was a definite depth of field problem in trying to carry focus when shooting directly across the three astronauts from left to right as they lay on their couches. In order to be able to crack the lens down sufficiently to hold all three of them sharp, it was necessary to force the negative one stop in development—but it worked out quite well."

Reflections of the lights onto the face-plates of the helmets constantly plagued the cinematographer. It was not possible to tone them down with a dulling spray, as is usually done in filming when something reflects too brightly, because this would have produced an unauthentic (and annoying) smearing effect. The only plausible solution was to *add* to the light reflections with even more of the same, so that they would seem to be caused by instruments within the space capsule. Toward this end, a special dashboard was built with multiple colored lights that could be beamed to reflect directly onto the face shields of the space helmets.

Another problem (and one for which there could be no really satisfactory solution) was that of trying to indicate the speed of the spacecraft, especially when the camera was shooting inside the capsule. Even though such craft travel at speeds of many thousands of miles per hour, they seem (even to those on board) simply to be hovering in space.

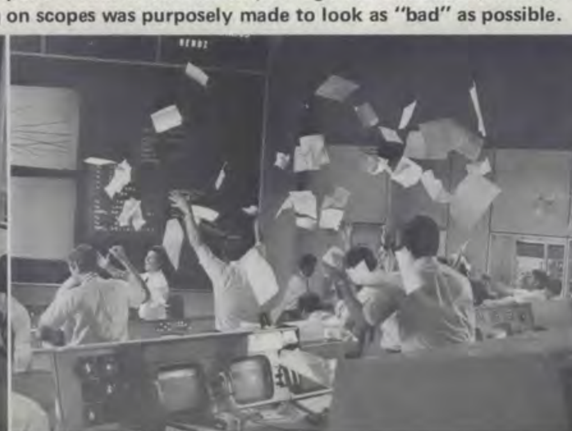
"You have just a couple of small windows in the capsule, and it's black outside most of the time," explains Fapp. "You couldn't very well send smoke rushing by outside the windows, or anything like that, in order to show speed. We added a bit of movement to the camera, of course, but that doesn't sell the idea of speed. I will say that when they're in orbit the sun really comes up in a hurry. We had to make some very fast light changes. I could hardly believe that sunrise comes on so fast in space, but I guess it does."

The many spectacular space exterior scenes, such as those illustrated here, were accomplished by means of the blue-backing matte process. They were staged against the huge 80 x 40-foot blue screen on Stage 27 at M-G-M Studios, using full-scale spacecraft, with some tie-in long shots (not involving actors) being filmed later by Special Effects, employing miniatures.

Fapp was confronted with some very special problems in shooting these blue screen scenes. At the time that the filming was taking place he had seen only

Continued on Page 1003

(ABOVE LEFT) Frame blow-ups showing various blue-backing composites of men and vehicles in space. (BELOW LEFT) Director John Sturges rehearses scene at control console. (CENTER) Mission Control technicians show wild jubilation at news of rescue of two of the astronauts aboard "Ironman One". Real-life reaction to Apollo 11 lunar touchdown, though more subdued, was no less joyful. (RIGHT) An astro-wife talks to her husband in space. Film shot for showing on scopes was purposely made to look as "bad" as possible.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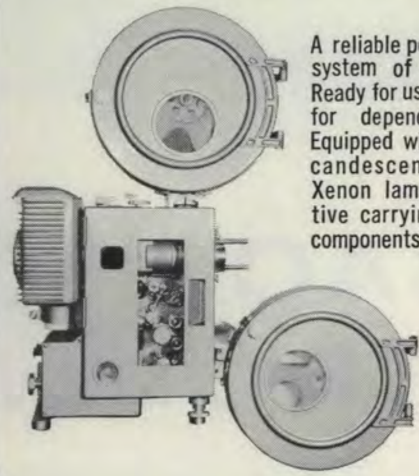

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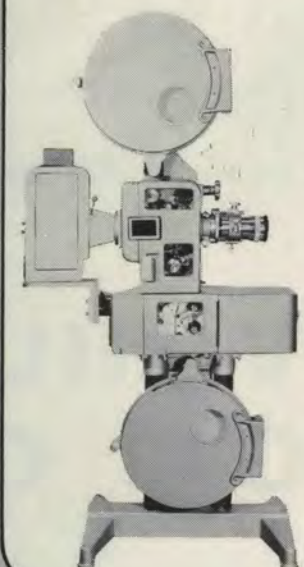

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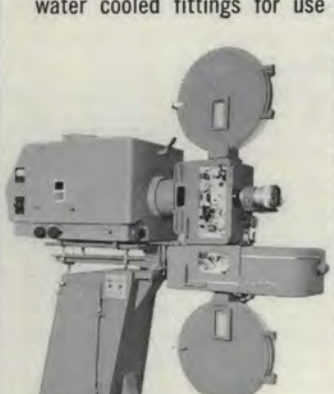

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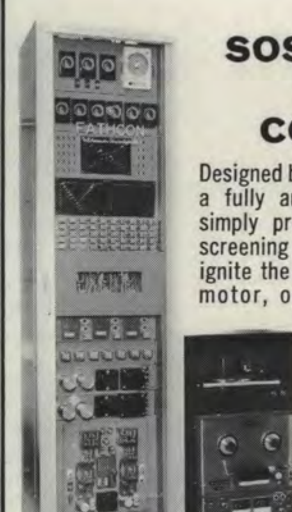

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MEANWHILE—BACK AT MISSION CONTROL...

While the Apollo 11 astronauts were walking on the moon, a trio of vigilant cameramen filmed the drama at Earth's "nerve center"

By CHARLES LORING

"We're go!" Neil Armstrong says, "Hang tight, we're go!" and the ugly-beautiful, spiderlike lunar module *Eagle* veers to avoid a crater as the super-cool astronaut with the friendly porpoise smile guides it expertly toward the moon's surface.

In the windowless dimly-lit Mission Operations Control Room on the third floor of Building 30 at NASA's Manned Spacecraft Center near Houston, 30 controllers sitting at four rows of gray computer consoles, monitor the hundreds of bits of data that came flashing up from gauges, dials and meters—and hold their breaths.

Moving silently among them, Bob Bird, Lead Cameraman of a crew of three from Houston's A-V Corporation, trains the 9.5mm-to-95mm zoom lens of his Beaulieu R16B 16mm camera on dramatic fragments of the historic scene. He shoots tense closeups of faces peering into scopes, readouts from flashing wall screens, inserts of rotating pencils, tapping pens, the snubbing-out of cigarettes.

Then, as the coldly impersonal computers register lunar touch-down, that calm voice comes winging back from

(LEFT) "Buzz" Aldrin shown inside the Apollo 11 capsule en route to the moon. Part of his assignment was to expose still and motion pictures of Neil Armstrong's historic first steps on the lunar surface. (CENTER) Clips from the film shot by Aldrin showing Armstrong descending from the LEM and taking Man's first steps on the moon. 1700 feet of 16mm Kodak Ektachrome MS color film (ASA 64) were exposed on the lunar surface. (RIGHT) Working in close quarters, Aldrin jockeys his motion picture camera into shooting position. Kodak Ektachrome EF film SO-168 (ASA 160) was used for filming inside the dimly lit lunar module.

deep space: "The *Eagle* has landed!"

A barely-restrained version of all Hell breaks loose in the Control Room. Cameraman Bird whips his lens about to capture the relief and elation of this momentous moment that can only happen once. It is on the film—locked in celluloid for posterity.

A-V Corporation, a commercial film company, is a prime contractor to NASA's Manned Spacecraft Center for audio-visual support and laboratory services, both still and motion pictures. It provides all motion picture services from script to screen, including script writing, editing and sound. Its photographic function is primarily in support of motion picture production. Engineering documentation is done by government cameramen, but A-V's cameramen have documented all of the manned space flights from Mission Operations Control for the past eight years, or since the beginning of the program. In addition, the company is contracted to NASA to produce training films, public affairs films, astronaut biography films, management briefing films, Congressional briefing films, etc.

In addition, A-V technicians process the overflow of motion picture footage at NASA's government laboratory on a follow-on (night shift) basis.

The three cinematographers who filmed the Apollo 11 activity in the Mission Operations Control Room (Lead Cameraman Bob Bird, Charles Turner and Jerry Bray) were there on what is euphemistically called a "non-interference" basis. In other words, they were working under some very tense conditions, shooting during the most critical phases of the flight. Therefore, the manner in which they conducted themselves was just as important as the skill with which they executed their photographic assignments. Had they gotten in anyone's way or caused the slightest distraction to any of the controllers, the flight operations director would have asked them to leave immediately. As it was, they executed their demanding chores without disturbing in any way the fine relationship which has existed between the A-V Corporation cinematographers and the NASA personnel since the beginning of the Manned Spacecraft flight program.

A-V Corporation's cameramen did not cover the Apollo 11 mission on an around-the-clock basis—not quite—but one or more cameramen were on hand to film all of the important highlights of the flight. Such key activities as the Lunar Orbit Insertion burn, Trans-lunar Insertion burn, De-docking, the lunar landing, the moon walk itself ("Extra-vehicular Activity"), Rendezvous and Trans-Earth Insertion burn were usually

The scene inside the windowless, dimly-lit Mission Operations Control Room at NASA's Manned Spacecraft Center during the Apollo 11 flight. Lead Cameraman Bob Bird of Houston's A-V Corporation (in circle) moves about filming with his Beaulieu R16B camera, equipped with 9.5mm-to-95mm zoom lens. Overhead can be seen banks of mixed blue fluorescent and incandescent lamps with color temperature close to daylight and a light level ranging from 7 to 16 foot-candles.

covered by two cameramen.

They photographed the busy "Capcom" (spacecraft communicator), the astronaut on duty who is the only one handling direct communication with the crew. They shot footage of flight operations director Christoper Columbus Kraft, who was in overall charge of the Mission Operations Control Room during the flight. They captured on film the individual functions of the 30 intense controllers at their consoles, and they would often cut away to the computer-controlled status board, with its readouts showing trajectories and other technical data.

During the more routine phases of the flight, one cameraman would hold the fort while the others took a breather. Lead Cameraman Bird was on duty from De-docking on through all of the lunar activities, including lift-off from the moon and *Eagle's* rendezvous with *Columbia*.

"After that I took about four hours off to go home and grab a shower and a couple of hours' sleep," he recalls, "but the excitement was such that I could hardly sleep."

The Apollo 11 flight marked the first time that the Beaulieu R16B camera was used inside the Mission Operations Control Room. Employed in conjunction with Eclair NPR and Arriflex cameras, it was equipped with a 9.5mm-to-95mm zoom lens, which was found to be preferable to the 12mm-to-120mm lens at the wide-angle extreme because of the "tight quarters" inside the facility. However, since the maximum aperture of the 9.5mm-to-95mm lens is F/2.2, it was necessary to run the Beaulieu to 20 frames per second in order to achieve an approximate exposure match between its lens and the F/1.9 lenses used on the other cameras.

In addition to the Beaulieu, Eclair and Arriflex cameras used in the control room, a Canon Scoopic 16mm camera was pressed into service for filming inside the Lunar Receiving Laboratory. Due to quarantine restrictions, no professional cameramen were allowed inside this facility. So Scoopics were given to non-professional people under quarantine and, because of the camera's ease of handling and efficient automatic exposure control, they were able to procure some adequate useable footage.

No lip-sync sound was recorded at Mission Control during the Apollo 11 flight, simply because there was no real necessity for it—although a certain amount of wild sound was recorded for background. Flight control loops of the entire mission were recorded by another contractor in the form of a 30-channel track, and A-V has access to these tapes if it cares to lift any of the air-to-ground sound. Some of this is used to lay in alongside shots of the Capcom talking to the spacecraft, or vice versa, but there is no real need for sync sound since a majority of the action will be covered by narration in the final editing.

One of the most challenging aspects of filming functions of the Apollo 11 flight at the Manned Spacecraft Center is the fact that the amount of general illumination available in the Mission Operations Control Room is practically non-existent, due, of course, to the fact that any great degree of overall brightness would interfere with precise perception of data displayed on the many screens and cathode ray tube monitors in the room.

The light level varies from 7 foot-candles to 16 foot-candles in the brightest area, which is where the flight operations director is located. To further complicate matters, the available light is a mixture of incandescent and bluish fluorescent, the blend having a color temperature somewhere in the neighborhood of 4,000° Kelvin. These lighting conditions, however admirably suited to the prime function of the room, are clearly anything but ideal for color cinematography. Even when using Eastman Ektachrome EF 7241 (Daylight) color reversal film, with its rated speed of ASA 160, it is theoretically impossible to get acceptable exposure under such low-light conditions—and yet, as the result of a two-year period of experimentation, technicians of the A-V Corporation contracted to NASA have worked out a system of shooting and printing which produces fully timed release prints of exceptionally good quality.

"Our first step in the right direction was to decide on using the EF Daylight emulsion rather than the Tungsten" explains William Robbins, A-V Corporation's Vice President in charge of NASA motion picture production. "We tried both emulsions and found that the Daylight stock color balance is better suited to the bluish light in the room. Not only are the overhead fluorescents decidedly on the cold side, but each console has a cathode ray tube monitor —a miniature television screen—and these reflect a very blue light onto the face of the people sitting before them. Of course, the color temperature in the original is *still* a bit off. We tried, in the beginning, to correct for this with filters while shooting, but the filters cut down the light. Also, since the quality of the light varied somewhat from console to console it was almost impossible to get a consistency of color temperature by compensating with filters. So now we leave the filters off and do all of our color correction scene-by-scene in the lab."

So much for color temperature—but what about the low light level problem?

"There is the obvious remedy of pushing the film in development," Robbins continues, "but we have found—as just about every other lab has—that if you push EF much beyond one stop, it starts to break up. You begin to get pretty bad grain and color shifts. So we expose wide open (at F/1.9), force the development one stop and then make a timed and color-corrected reversal master positive by contact printing onto A-wind Eastman 7388 release print stock, putting all the light we can through it in the printing. If the master is still a bit too dense, we can print it up even more at the release printing stage. In effect, we are ending up with a result as if the EF were rated at ASA 1,000. By using our Bell & Howell Model C printer with the additive light source, correcting for density and color balance at the same time, we've been able to maintain clear whites, good flesh tones and acceptable grain—in short, a very good product. What makes it possible is the use of the 7388 stock for the master positive, because it is of lower contrast than the ECO we were using in our early tests."

Robbins gives much credit for the development of this technique to laboratory supervisor Frank Zehentner and color timer Ray Harris.

A-V's three-man camera crew exposed a total of 12,800 feet of 16mm EF film in the Mission Operations Control Room during the spectacular Apollo 11 flight. Added to this is the footage exposed by the Command Module's on-board 16mm cameras—plus kinescopes from the material sent back by television cameras in space.

Footage from these three sources has been combined to edit a dramatic 34-minute documentary called "APOLLO 11 . . . FOR ALL MANKIND" which supplements the official public affairs film, "THE EAGLE HAS LANDED", produced by the motion picture facility at NASA's Washington headquarters. In addition, an Apollo 11 Mission Report on film has been edited exclusively for the Manned Spacecraft Center. Excess footage has been catalogued and incorporated into the millions of feet of film on file in the Stock Film Library which A-V Corporation maintains for NASA. This footage is made available to commercial producers and television networks. ■

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THE MANY-MINDED TELEVISION ROBOT THAT REPORTED THE APOLLO 11 LUNAR VOYAGE

How a custom-built system, geared to the Space Age created simulations for the CBS moon-walk telecast

By WILLIAM INGE

A graphic display projection system that composes sentences, creates moving diagrams and simulates events all by remote command made its debut during the CBS television news coverage of the Apollo 11 moon mission.

Following the progress of the flight from lift-off to splashdown, the system drew from its extensive storage of words, symbols, diagrams, backgrounds, graphic "organizers," and special effects to clarify news events as they occurred. Operators of the system could "orchestrate" images, creating new graphic situations at will—including animation effects—in immediate response to news reports fed to CBS by Apollo Mission Control in Houston.

The system is described by its developer, Douglas Trumbull, head of Trumbull Film Effects, and creator of many of the effects for the film, "2001: A SPACE ODYSSEY," as the most flexible and complex of its kind. It utilizes nine L-W 224A-TV 16mm motion picture projectors, each with a maximum random-access storage capacity of 9,999 separate images. A Mast 35mm filmstrip projector provided moon backgrounds, diagrams, grids and special titles. Development cost for the system and graphics was $100,000.

Images were projected either in the still mode or at very low frame rates. This technique permitted high image storage capacity and rapid accessing.

Three operators manned the master control, selecting and combining images and effects stored in the system to create "real-time" visual aids for CBS viewers. A typical projected image, as composed by the operators, might include a moon background with important craters and features labeled, a moving space vehicle with a dotted line tracing its path, and any words or titles needed to explain the situation. Other composed images simulated docking maneuvers and star sightings being made by the astronauts.

THE SYSTEM

The system consists of nine motion picture projectors, one 35mm filmstrip projector, a master control console, a rear projection screen 5 feet wide by 3 feet high, triggering circuits, counters, and the film itself.

Projectors

Key element of the system is the L-W 224A-TV 16mm motion picture projector. Besides being fully compatible at all operating speeds with TV scanning, the projector has an extremely short pull-down time which permits completely flickerless operation at all frame rates. The 224A-TV also operates with full brilliance in the still mode—which was the principal mode used during the Apollo 11 coverage—and allows instantaneous stop, start, and change of direc-


CONVERSATION
TRUMBULL FILM EFFECTS
CALIFORNIA
22
22
51 (BARBEQUE)
52 BEAUTIFULLY
53 CBS
54 CERTAINLY
55 COLLINS
56 MICHAEL COLLINS
57 COLUMBIA
58 COVERAGE OF
59 DAVID
60 DUE
61 EAGLE
62 EATING
63 EVENING
64 FINE,
65 FLIGHT TO
66 GOOD
67 HAL 10,000
68 HAPPY TO REPORT
69 HELLO
70 HOW ARE YOU
71 I AM
72 I DO NOT HAVE
73 IS
74 IS ENTERING
75 IS EXPECTED SOON
76 IS IN
77 IS ON THE
78 IS ORBITING
79 IS PERFORMING
80 IS PROCEEDING
81 IT IS
82 I WILL FIND
83 LIFTOFF
84 LOOKING FORWARD TO
85 LOSS OF SIGNAL
86 LUNAR SURFACE
87 MAY I CALL YOU
88 MILES FROM
89 MOON
90 MORNING
91 MR. CLARK
92 MR. CRONKITE
93 MR. SCHUMACHER
94 MY PLEASURE
95 NEARLY
96 NO
97 NOMINALLY
98 OF COURSE
99 ON THE FAR SIDE
00 OUT OF RADIO CONTACT

The system used by CBS to simulate events during the marathon Apollo 11 telecast combined words, symbols, diagrams, backgrounds, graphic "organizers" and special effects to clarify situations as they occurred. (ABOVE) Each number on planning sheet represents individual film frame. (LEFT) A typical news bulletin title composed on the air from images stored in several projectors. (RIGHT) Any one of the thousands of film frames could be accessed and positioned from this 10-foot wide console, which has full controls for every projector in the system. A 100-foot cable connects the console to the projector array.

(LEFT) Walter Cronkite and Wally Schirra report events of the Apollo 11 flight from CBS Studio, while on screens below them visual composites assembled by the unique system illustrate graphically what is happening. (CENTER) A title composed on the air from stored images. (RIGHT) Referring to his planning sheets, the operator at the console selects from the system's vast vocabulary to create "computerized" messages.

tion at any speed. The unit is basically an Eastman Pageant projector which has been re-engineered by L-W Photo, Inc., of Van Nuys, Calif.

The nine 16mm projectors were mounted in a compact three-tier array. Each unit was set in a cradle which permitted tilt movement, and each cradle was mounted on a rotating baseplate for pan motion. Projectors were therefore individually controllable for the positioning of images in desired locations on the screen.

Projector images were reflected onto the rear-projection screen by means of a 45°-angled mirror. With a throw of 20 feet from projector to mirror, there was no apparent parallax or distortion problem, even though the units were projecting from different positions within the array.

The screen was divided into 1000 locations on x-y axes, all selectable from the master control console. On pushbutton command, projectors would seek their new coordinates, and a new image would appear on screen with all elements in the proper relationship. Positioning could then be fine-tuned by means of 10-turn precision potentiometers.

Stored in the 35mm filmstrip projector were several titles, 45 different views of the moon, and various graphic organizers, such as grid lines. The 35mm unit, made by Mast Development Co. of Davenport, Iowa, was mounted in a fixed position slightly to the rear of the 16mm projectors, aiming between two of them.

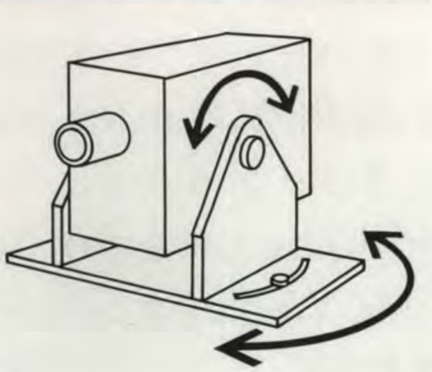
Every projector was equipped with three color filters and a blackout flap, all operated by remote control. The filters—yellow, magenta and blue—could be combined to create a wide variety of colors. The blackout plate permitted on-off effects, such as blinking words and arrows.

Console

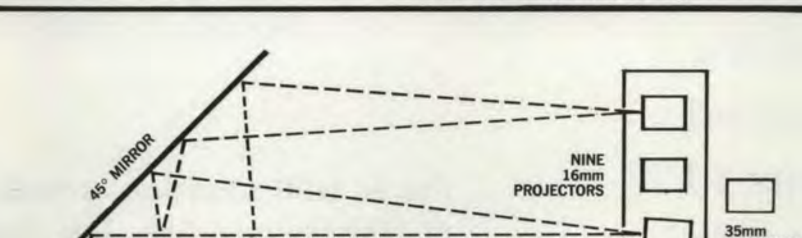
The master control console, with full remote controls for each of the ten projectors in the system, is 10 feet wide. During the Apollo 11 telecasts, it was situated 40 feet away from the projection screen.

Controls for every projector include four counter dials which permit the pre-selection of any film frame. The operator first presets the desired frame

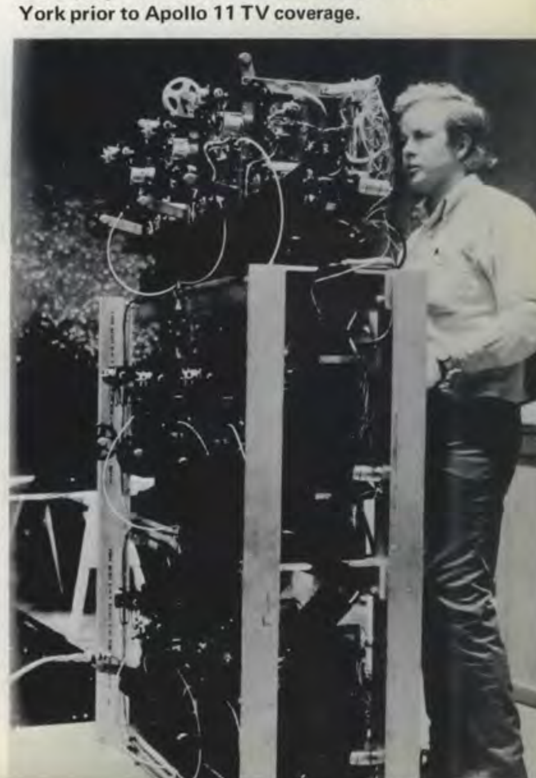
Continued on Page 1011



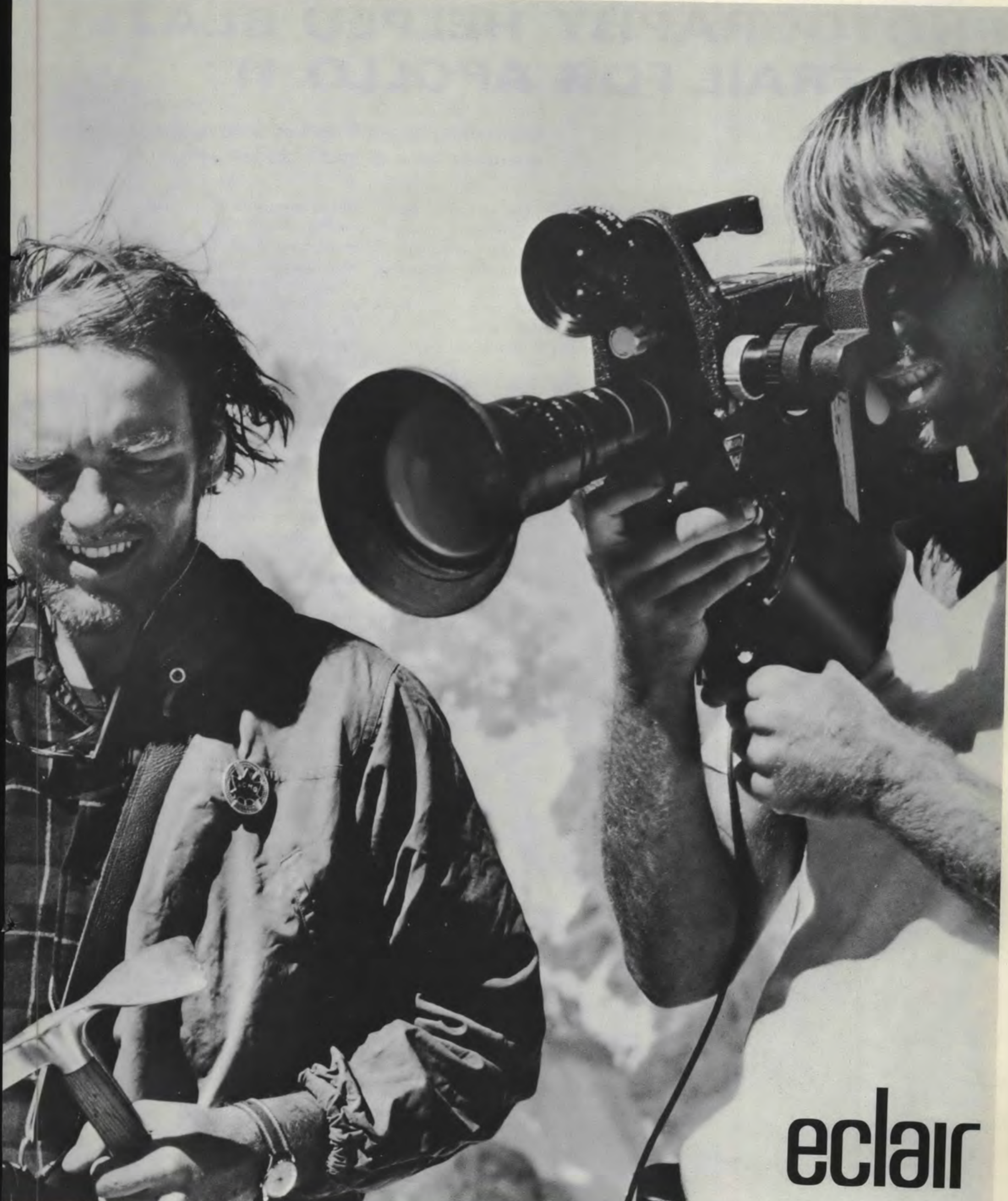
(LEFT) Cradle mount and rotating base plate make possible remote control of pan and tilt functions for each 16mm projector in system. Images are precisely positioned on screen according to pre-established x-y co-ordinates. (BELOW) Diagram shows how images from several projectors are reflected from 45° mirror onto rear-projection screen.



Douglas Trumbull, developer of the system and head of Trumbull Film Effects, checks out multi-projector array at CBS Studio in New York prior to Apollo 11 TV coverage.



Soundman Charles Groesbeek and cameraman-director Michael Wadley photographed at the summit.



HOW KODAK'S ROLE IN SPACE PHOTOGRAPHY HELPED BLAZE THE TRAIL FOR APOLLO 11

Continuing research makes possible the photo documentation of man's boldest adventure

The brilliant flight of Apollo 11 and the landing of the first men on the moon—a landmark in America's reach into space—not only was recorded for posterity on Eastman Kodak film but also followed a trail blazed by Kodak photo systems in five unmanned Lunar Orbiter shots.

Each of the Lunar Orbiters was equipped with a self-contained photographic laboratory, designed and built by Kodak, that not only took pictures of the moon's surface, but processed them and transmitted them back to earth. The first three Lunar Orbiters were so successful in photographing the moon's surface—with special emphasis on detailed pictures of nine potential Apollo landing sites—that the last two missions in the series were available to photograph the entire surface of the moon and previously unphotographed areas. From the pictures transmitted to earth—and confirmed by the manned lunar orbit of Apollo 8 in December, 1968—the three best sites for Apollo landings were chosen.

The hostile climate of the moon put incredible demands upon the science of photography, leading to the development of new film stocks, cameras and methods of development—all of which are helping to advance man's picture-taking on earth.

As in every manned space shot since Col. John H. Glenn, Jr. orbited the earth Feb. 20, 1962, the crew of Apollo 11—Neil A. Armstrong, Michael Collins, and Edwin E. Aldrin, Jr.—used film made by the Rochester, N. Y., company to record their epic journey.

Aboard the Apollo 11 were three rolls of 70mm, one roll of 35mm and 10 rolls of 16mm Kodak Ektachrome MS film S0368 (Estar thin base); two rolls of 70mm and two rolls of 16mm Kodak Ektachrome EF film S0168 (Estar thin base), and five rolls of black-and-white Kodak Panatomic X recording film S0164 (Estar thin base). Each roll of 70mm film was long enough for about 160 exposures in a modified Hasselblad camera. The rolls of 16mm film were 140 feet long and were exposed in a Maurer picture-sequence camera.

The 35mm roll was long enough for 100 stereo exposures in a special lunar surface close-up camera especially made by Kodak for the National Aeronautics and Space Administration for scientific study of the moon's surface. The camera, slightly larger than a cigar box, was designed specifically for use by astronauts in bulky space suits and gloves.

It was only in January of this year that NASA authorized Kodak to design and build the camera. To meet the demanding time schedule, the engineers relied chiefly on pre-existing Kodak designs for lenses, automatic film-advance mechanisms, and other parts of the camera.

The result was a camera that, when stowed, measured only 12.9 inches high, and, when extended for use, was 14.5 inches high. A handle, which telescoped to a length of 32 inches allowed the astronauts to trigger the shutter and an attached electronic flash without bending. The film was advanced automatically. Two fixed focus 46mm six-element lenses, separated to provide a 9-degree stereo angle, allowed anything visible a quarter-inch above or below the plane of focus to be registered sharply on the film. Objects more than twice that distance above or below the plane of focus would be easily recognizable.

Only the film cassette, protected from light by rubber rollers, was returned to earth. The camera was left on the moon's surface to lighten the load of the upper stage of the lunar excursion module during its rendezvous with the command module of Apollo 11 in lunar orbit.

Lunar surface scientific and photographic data recorded on the film are for an experiment for which Professor Thomas Gold, director of the Center for Radiophysics and Space Research at Cornell University, Ithaca, N. Y., is the principal investigator.

Although the dramatic pictures of the moon landing and the earlier Gemini space walks have had the greatest impact on the public, Kodak's behind-the-scenes role has been an integral—and vital—part of both the manned and unmanned space programs.

Few people, for example, are aware of the essential role of photography in the testing and engineering that have made these flights possible. In one of the early lift-offs from Cape Kennedy, 62 motion picture cameras loaded with Kodak film were focused on the launching pad. A dozen of them were intended for a documentary of the flight. The remaining 50, however, had the task of watching specific performance functions, such as the operation of the mechanisms that held the rocket in place and fed it power until lift-off.

The launch of each of the Apollo flights is photographed simultaneously by no less than 205 cameras, protected by ablative materials and quartz lens covers from the intense heat of the rocket blast. Analysis of the rocket's exhaust, photographed close-up and in slow motion, is made possible by XR film, manufactured by Kodak. This three-emulsion color film, whose layers range from slow through medium to fast, shows full details of the flame on takeoff. A single-speed film would lack sufficient range of exposure to record the entire blast.

Still another film, Kodak Shellburst Panchromatic, a black-and-white film with an extended red sensitizer to increase its ability to photograph a rocket's exhaust, tracks the lift-off. It is used

(LEFT) In the Precision Photographic Laboratory of the Manned Spacecraft Center in Houston, a technician works at the darkroom end of the Versamat film processor. (RIGHT) The latest type of film cleaning machine is given a constant workout in the Precision Photographic Lab, a model of the most advanced film processing facility.

in theodolite cameras to record information on the rocket's trajectory, such as drift and yaw as related precisely to time and azimuth.

Equally important, many miles of Kodak oscillograph paper are used during each flight to record telemetry signals that indicate engineering measurements such as temperature, pressure, velocity, acceleration, vibration, and fuel flow. The photo paper allows use of a light beam which works faster and makes more accurate traces than does any mechanical system employing a stylus. These papers require no processing, so can be examined immediately after exposure. Speed of recording is as high as 80,000 inches a second with a high intensity light source.

Kodak Datacolor paper, first used to record data from Mariner on its flight to Mars, permits telemetry traces to be superimposed on one another so that engineers can relate them quickly to each other and tell precisely what is happening at any given instant. Black and white traces would be difficult or impossible to separate and relate. The Kodak paper shows lines in three different colors—red, blue-green, and black—making it possible for each trace to be followed with ease.

One of the most significant developments for unmanned space exploration was the introduction in 1963 of BIMAT transfer film by Kodak scientists who wanted "to see where" it might serve government and industry. This film, which consists of a polyester support carrying a hydrophilic layer of processing chemicals, is used in conjunction with a compatible recording film, such as Recordak Dacomatic film S0337.

When placed in contact with the recording film and held in a special processor, the chemicals in the BIMAT film develop the recording film. When the two are peeled apart, the recording film contains a negative image and the BIMAT film a positive image, allowing immediate study of the latter and paper print enlargements of the former.

The technique first was used in space exploration in the Ranger 9 program to convert electronic images of the moon being beamed back to earth into high-resolution photographs. The images were recorded from cathode ray tubes, which are similar to television tubes in many respects, on the Dacomatic film, which was then "dry" processed by use of BIMAT film. Scientists at the Jet Propulsion Laboratory were able to analyze the resulting photographs while pictures still were coming back from the moon. Since then, the same system has been used to convert the electronic images from the Surveyor moon project and the Mariner Mars probes into equally high-resolution photographs.

Most important, however, was that the BIMAT process made the success of the Lunar Orbiters possible. Pictures taken on Kodak's high resolution aerial

Apollo 11 Astronauts Armstrong, Collins and Aldrin examine a few of the hundreds of separate photographs which they exposed during their lunar flight and historic moon-walk. Aside from their artistic beauty and value as documentation, the photographs serve a valuable educational purpose in many areas of the space program.

films by the Orbiters' telephoto and wide angle cameras were developed by the process inside the space capsule. A flying spot light source and an optical-mechanical scanner utilizing a photo-multiplier tube converted the negative film images into electrical signals that were beamed to earth.

The signals, received at one of the Deep Space Instrumentation Facilities at Woomera, Australia; Madrid, Spain; or Goldstone, California, were sent to ground reconstruction electronics equipment supplied by Kodak. This equipment converted the video signals to a line scan on a cathode ray tube which was recorded on 35mm film. The processed film was sent to Kodak where the ground recorded images from the spacecraft were reassembled on special equipment built by the company. The reassembled pictures were so detailed that Lunar Orbiter II provided high-quality photos of the Ranger VIII impact area and Lunar Orbiter III positively identified the Surveyor I landing site and the spacecraft itself.

Vital as the accuracy of these photos were to the success of the Apollo 11 moon landing, they are but part of a continuing contribution by Kodak to the success of America's ventures into space. Photo resists and high resolution plates have made possible the micro-miniaturization so essential to spacecraft. X-ray films provide constant checks on rocket and spacecraft construction and fuel systems. New solar films record sun flares that can pose extreme radiation hazards in outer space. Infrared and other films can amass data needed by scientists for studies not only of space but of earth itself.

Five historic photographs recording man's first steps on the moon—the culmination of the greatest journey of all time, the epic flight of Apollo 11—were dedicated recently at the Kodak Colorama in Grand Central Station.

The photographs, taken by Apollo commander Neil A. Armstrong, were blended into a massive 18 by 60-foot composite to form the world's largest color transparency. In dedicating the Colorama, Dr. Louis K. Eilers, president of Eastman Kodak Company, said:

"We present it to the people of New York as a tribute to the astronauts of Apollo 11 . . . and to the entire National Aeronautics and Space Administration team.

"We are proud, humbly proud, of our part in this leap forward for mankind."

The dramatic pictures show Astronaut Edwin E. "Buzz" Aldrin Jr. descending from the lunar excursion module against the stark surface of the moon and the cold darkness of space, setting up the seismometer left behind by the astronauts to record moonquakes and the impact of meteorites, walking toward Armstrong with the LEM and the photographer reflected in his face plate, unloading equipment from the LEM's storage compartment and, finally, standing beside the American flag unfurled on the lunar surface. One of the photos shows the special stereo camera developed by Kodak to record the texture and characteristics of the moon's surface.

Noting that photography has been one of the key recorders of man's conquest of space, Dr. Eilers said:

"Color film allows the people of New York and the entire world to share in the experience of man's first physical contact with the moon. We at Kodak look forward to future opportunities for photography to be in partnership with very special people doing very special work."

The Colorama was accepted for the people of New York by Dr. Timothy Costello, deputy mayor, and on behalf of NASA by Dr. Robert Jastrow, director of the Institute for Space Studies, Goddard Space Flight Center. It is part of an extensive collection of photographic prints of all the Apollo missions that will be displayed in the Kodak Exhibit Center in the terminal. More than 50 pictures, including 12 of the Apollo 11 flight, will be shown. ■

Splashdown and Recovery, by the dawn's early light—final phase in an epic journey. Navy frogmen are seen in completion phase of attaching flotation collar to the space capsule, blackened by its fiery re-entry into the earth's atmosphere.

They shoot with no lights, no tripod, and sometimes, no hands. Mostly they know how to fade into the woodwork and seem to practically disappear

JPL cameraman John Gregoire films ground support equipment that transmits signals to spacecraft. (RIGHT) Double-system sync sound is shot with 16mm Eclair camera linked to Nagra recorder. Shot-gun microphone is mounted above viewfinder. Cameraman holds an audio-visual slate which records scene starts simultaneously on film and recording tape.

THE QUIET CAMERAMEN

By HENRY PROVISOR

A score of technicians, engineers and scientists huddle over a console, staring at a TV image showing a series of ever-changing figures. No one speaks. The tension is so intense that everyone is transfixed, unmoving, and quiet.

But there is one faint sound.

It is a motion picture camera, hand-held by a quiet cameraman.

The light, of course, is impossible . . . a few fluorescents overhead and nothing more. But the cameraman continues to shoot and steps softly from one set-up to another so that he seems to melt right into the background. The group around the console ignores him. Now he is practically invisible.

"That's how it has to be," says Everett De View, photo supervisor at Cal Tech's Jet Propulsion Laboratory in Pasadena, California. "We can't use any extra lights, reflectors, tripods or assistants, and we must disturb no one."

The quiet cameraman is recording the events that occur when a spacecraft is sent hurtling into space and then begins to send back the tiny signals generated millions of miles from earth. At this writing, Mariner 6, orbiting Mars 59 million miles away, continues to return information about speed, direction, temperature, heat inside the spacecraft, condition of the batteries and a mass of other data, as well as transmitting photographs to Earth.

Surveyor, the spacecraft that flew to the moon in 1966, for example, sat down gingerly on the lunar surface and sent back more than 11,000 pictures so detailed that the spacecraft's footprints could easily be identified. So, it must be pretty evident that this is the decade of the camera. And the motion-picture camera is part and parcel of the entire scheme of things. It is used here to record assembly of the vehicle, check-out, environmental testing, and finally, the actual launch. In addition, the camera records the events that take place later, when the masses of data are returned to the earth environment.

"We have eight cameramen at the Jet Propulsion Laboratory, and all are trained to be quiet, competent and unobtrusive. They have to be—otherwise they would interfere with the scientific work—and we can't have that, of course," said De View.

He explained that shooting in the Space Flight Operations Facility is especially trying. There, signals and data are received from all over the world, by phone, cable, radio and teletype. And many pieces of data come in from the big antenna at Goldstone, California. Here they are processed, evaluated, stored, and later employed to perform tactical maneuvers, when necessary.

"Our biggest problem is light. The

(LEFT) Working with available light and no tripod in Space Flight Operations Facility of Cal Tech's Jet Propulsion Laboratory, cameraman films instrumentation data from TV monitor. (CENTER) Assembly of spacecraft is recorded on film to be used as a visual report to NASA. (RIGHT) Newsmen gather in Von Karman Auditorium just after lift-off of Mariner spacecraft that televised pictures from Mars. Auditorium was designed with 300 foot-candles of light, ample power and remote microphones, all for the benefit of the press.

level here is about 20 foot-candles, but we can't bring in any supplemental lighting equipment for fear of disturbing the people at work. In fact, we are here only by special permission and with the reservation that we remain practically invisible, quiet, and anonymous.

"To meet these conditions," De View explained, "we use Kodak's EF 7241 Daylight film which has an ASA rating of 160. We shoot this at 125 to compensate for the 20M gelatin filter we employ to kill the green tinges you get with fluorescent light.

The first picture of the earth from the moon, sent back by the first spacecraft to achieve lunar orbit. Picture was produced by means of mosaic of telemetry signals flashed to earth and later converted into range of gray tones. Though far overshadowed by photographs made later during Apollo flights, this wide-angle shot caused a sensation at the time.

Filming Mariner spacecraft illuminated to simulate conditions in the vacuum of space. 40,000 watts of power were used to light 18-foot space voyager hung by cables against black velvet background.

"Mostly we use zoom lenses on our Arriflex and Eclair cameras. We have an Angenieux (12 to 120mm), a Zeiss (12.5 to 65mm), and a Pan Cinor (17.5 to 70mm). At about F/1.4 and 24 frames, we get good, usable film."

Asked whether he found it necessary to push the film rating at times, De View replied that this was done in rare cases. They expose at a speed of 250, and even 500, but the results are not as good as using the conventional film rating. Tough as they are, these conditions produce good film, but almost all sequences have to be shot wide open, F/2.0 or F/1.4. This again poses other problems.

"You can't get too close at these openings since the depth of field is quite shallow. So then, to make the best of things, we calculate very carefully the extreme near and far distances to get the best possible focus," said De View.

Then too, he explained, since the camera is almost always hand-held, the problem of resolution due to movement is ever-present. To solve this particular problem they tested many shoulder pods and finally found one that worked well. This was the type similar to the harness used to carry a flag on parade. The camera is fitted with a short, metal bar which is in turn fitted into the leather holster worn around the waist of the cameraman.

"With this rig the cameraman is freer than with other types of shoulder pods; and besides, if he has to, he can remove the equipment very quickly," he explained.

He told us that many of the films were shot as filmed reports and submitted periodically to NASA to supplement the printed reports.

"In other words, cold type alone is not enough. This is the era of the camera because it fills the gap and describes visually what happened," he said.

Back in 1941, George Emmerson, who created the photography department at the Jet Propulsion Laboratory,

Continued on Page 1014

(LEFT) Eclair camera with shotgun mike held by custom bracket. (CENTER) Nagra recorder with special "black box" designed by Jet Propulsion engineers. (RIGHT) Power pack with modified circuitry for driving camera-recorder combination. In foreground is the electronic slate, a light and oscillator combined in compact package.

THE CAMERA IN ORBIT

Hasselblad's presence on all of the manned space flights has earned it a deserved permanent place in the Universe

Since the Mercury's Sigma 7 flight, Hasselblad cameras have been the workhorse of still photography documentation on all of NASA's manned space flights.

Most of the photographs seen in newspapers and national magazines after each flight were taken with the 500C model Hasselblad. But on the Gemini 10 to 12 flights, the Super Wide C was used for the weather and terrain photographs usually assigned to the 500C. The Super Wide's 90° angle photographic capability produced some spectacular photographs showing more of the curvature of the earth than ever before.

Some of the other more famous photographs taken with Hasselblad cameras are the Agena rendezvous and docking maneuvers and those of the dramatic meeting between the Gemini 6 and 7 crafts.

The off-the-shelf Hasselblad cameras NASA uses for space photography are slightly modified for weight and space factors, important considerations in space travel, and anodized to prevent glare. The cameras are also fitted with larger magazines pre-loaded with a special thin-base film, made especially for NASA by Kodak.

After the Hasselblad proved its capabilities of photographing in a vacuum when it produced the dramatic photographs of America's first spacewalker on Gemini 4, each astronaut following in his footsteps was equipped with a Hasselblad. During the Gemini 10 spacewalk, a Super Wide C worked loose from its tethered mooring on Michael Collins' spacesuit and was lost somewhere over Australia about 250 miles high. As far as anyone knows, it is still orbiting the earth.

For their photographing, the astronauts used a pre-set exposure for infinity with a setting of f/11, 1/250 sec. and aimed through their hatch windows to take most of the shots. Measuring 6¼ x 4¼ x 4¼, the camera is easily hand-held even by spacewalkers with protective gloves on.

The first Hasselblad used in space by Walter Schirra on his Mercury Sigma 7 flight is part of the manned space flight exhibition at the Smithsonian Institution in Washington, D.C.

The Apollo 11 astronauts documented their entire historic moonlanding voyage in still photographs taken with three electric Hasselblads. One of the cameras was special for the EVA or walk on the moon; the others are the same versions of the EL/70 models used on the last three flights.

The "different" Hasselblad is distinguished by its silver appearance, a new Zeiss Biogon 60mm lens, and a Reseau plate for precise measuring of areas photographed.

According to the distributors of Hasselblad cameras in the U.S., Paillard

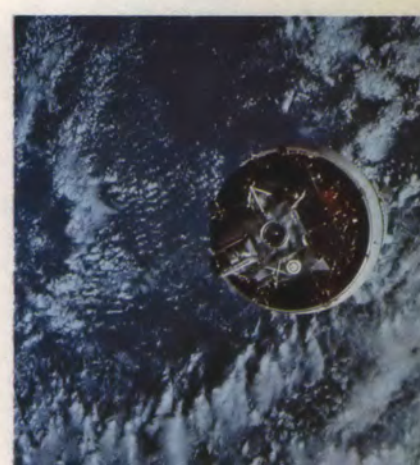
(LEFT) Neil Armstrong with moon-camera strapped to his chest. (RIGHT) The unique beauty of outer space recorded by Hasselblad cameras.

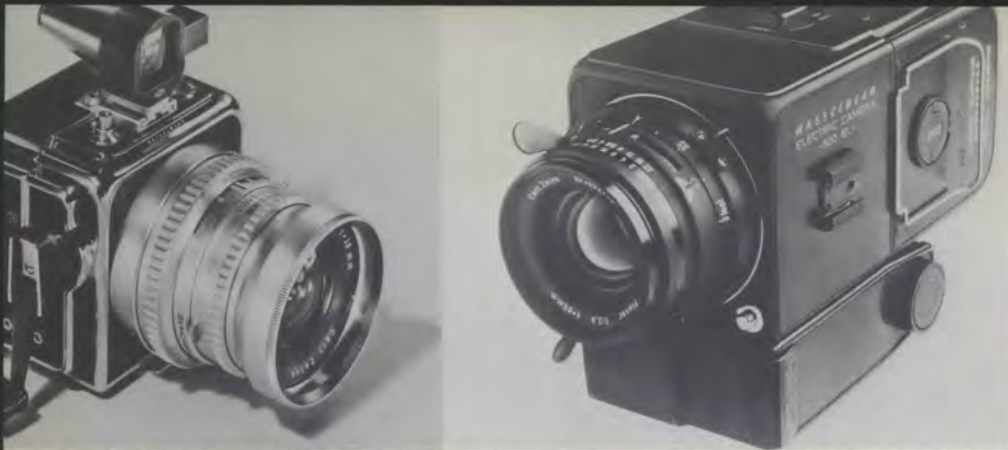






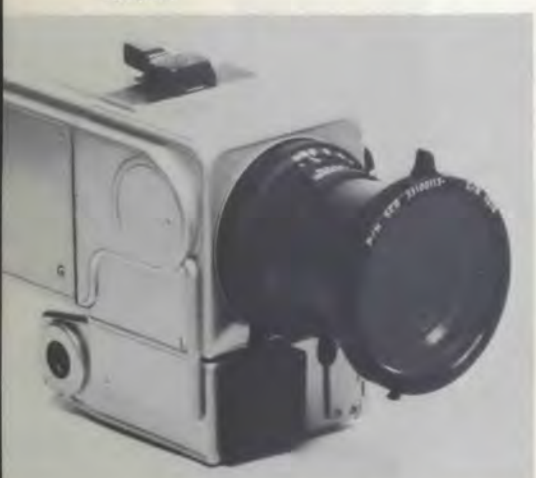




(LEFT) Hasselblad SuperWide C extreme wide-angle camera of the type lost in orbit 240 miles above earth during Gemini 10 spacewalk when it worked loose from tether attached to astronaut Michael Collins. (RIGHT) Electrically driven Hasselblad EL/70 camera.

Silver model of EL/70 Data camera used by Armstrong during the moon-walk. Silver camera case and magazines helped keep equipment at a more uniform temperature on lunar surface.



Incorporated, Linden, N.J., this marks the first time a photo-gammetric device has been successfully adapted to a single-lens reflex camera. Adaptation of the Reseau plate to the 2¼" square size film format camera was made especially for NASA by the Hasselblad factory staff in collaboration with Carl Zeiss.

Silver was chosen for the Hasselblad EL/70 Data Camera, its special 60mm lens, and the three film magazines exposed on the moon in order to keep the equipment at a more uniform temperature. Hasselblad cameras carried on previous manned space flights have been anodized in black as those used on the Command Module were. Besides their silver color, the moon camera and magazines were fitted with a tether ring which was latched out of the way when not in use for lowering and raising to and from the LM. Only the magazines returned to earth.

Posterity will have the fantastic venture of man's first hours on the moon recorded completely and, for the most part, in color still photographs. Two magazines with a higher speed (160 ASA) Ektachrome than ever used by astronauts before were designated for use inside the dimly-lighted Lunar Excursion Module.

According to NASA, Armstrong and Aldrin used the Hasselblad Data Camera extensively during their surface EVA to document each of their major tasks; for a 360-degree overlapping panorama sequence of still photos of the lunar horizon; and to record surface features in the immediate area as well as for close-ups of geological samples and the area from which they were collected and a survey of the lunar module for its appearance after landing.

A magazine of black and white Panatomic X (ASA 80) film was used to record the LM's descent on the moon. Magazines can be loaded with up to 200 frames of black and white film and up to 180 frames of color film. Six film magazines, two color and four black and white, were exposed on the Command Module throughout the voyage.

The Hasselblad used inside the LM during the "mooning" had the Zeiss Planar 80mm lens normally used on the cameras. The Command Module camera had a 250mm Zeiss Sonnar telephoto lens and an 80mm. All of the bayonet mounted lenses for Hasselblad cameras are interchangeable as are the film magazines, an important reason for the camera's use on all manned space missions since Walter Schirra's Mercury flight in October of 1962. The camera is credited with producing approximately 7,500 photographs to date.

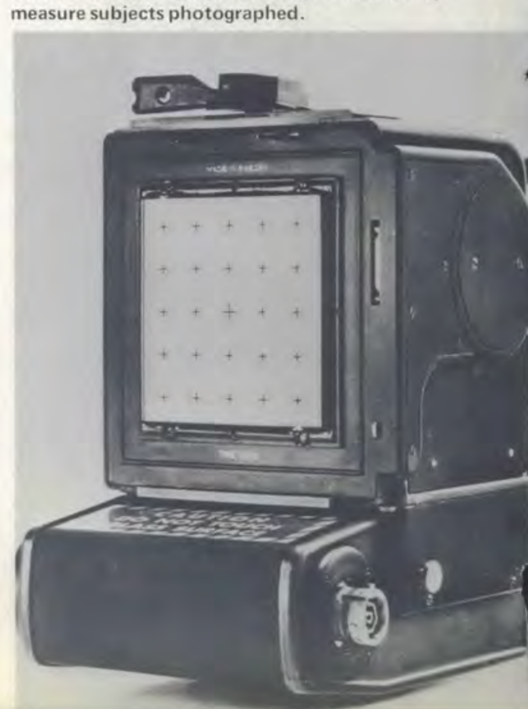
For the EVA photography, Aldrin lowered the camera and magazines to Armstrong who then attached it to a special bracket on his PLSS (life support system) check pack. The camera could be locked on the bracket during use and easily removed by sliding it along about a four-inch track making it accessible for hand-held shooting by either astronaut.

During Apollo 11, the electrically driven Hasselblads which advance the film automatically were used to expose nine film magazines totaling approximately 1,720 frames: In exposing these frames, Astronauts Neil Armstrong, Michael Collins and "Buzz" Aldrin have provided mankind with lasting proof of many aspects of its boldest adventure.

Hasselblad still photographs from past manned space flights have proven their importance as aids in evaluating missions and in earth and weather studies. The value of the sharp, clear 2¼" square photographs the astronauts took in space with their Hasselblad cameras was demonstrated to the point where photography became one of the prime experiments on Apollo 9. But perhaps their greatest importance is simply to let us see and wonder at our universe and accomplishments. ■

Hasselblad EL/70 Data camera with side-plate removed to show electric drive which advances the film automatically. Special magazines hold up to 200 frames of 70mm black and white film, or 180 frames of color.

The Reseau grid plate, built into the 500EL Data camera, helps photoanalysts accurately measure subjects photographed.



THE "SLIT-SCAN" PROCESS

as used in 2001 A SPACE ODYSSEY and beyond...

Details of an exciting new "light-in-space" technique for filming in the Space Age

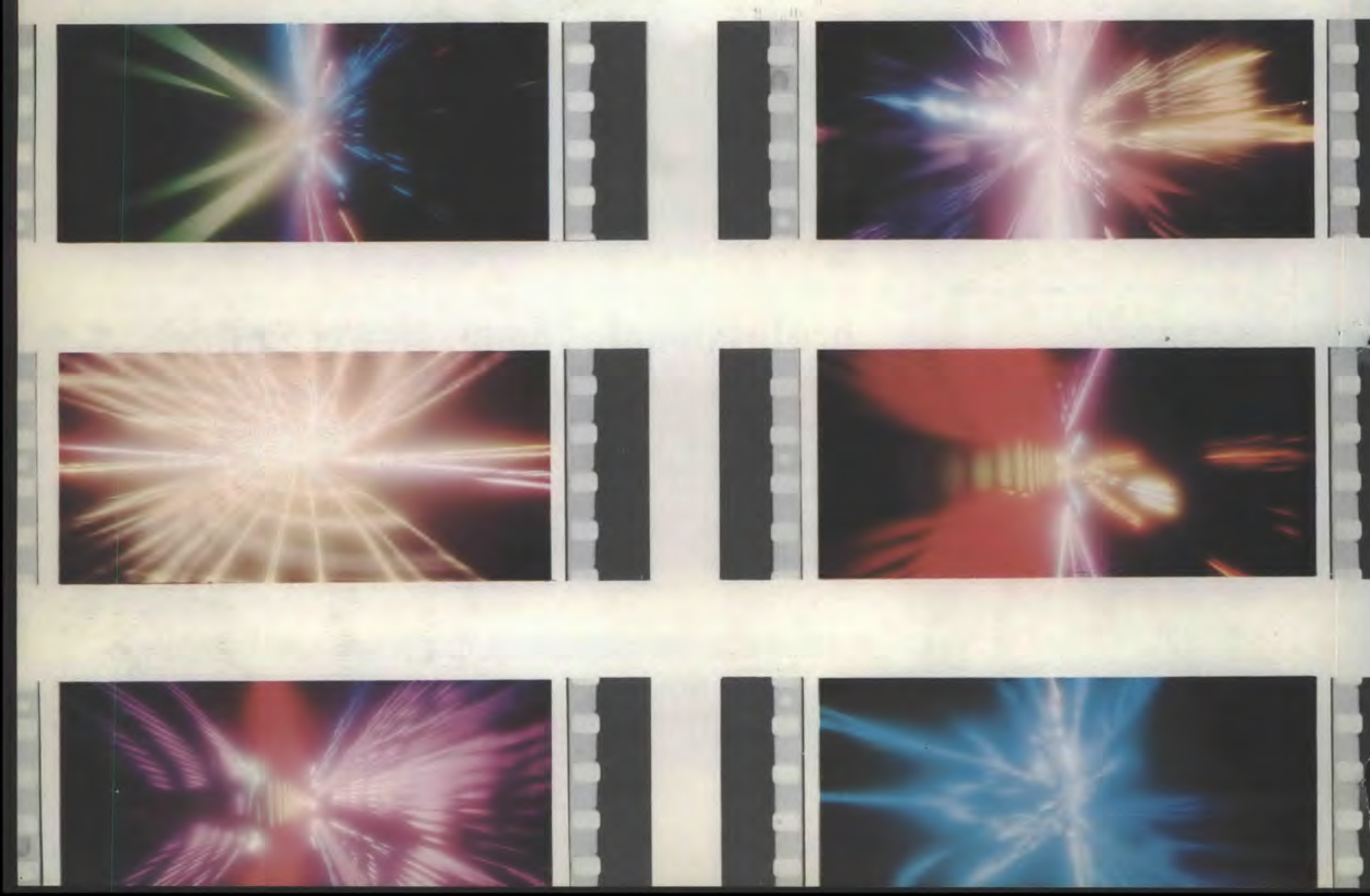
By DOUGLAS TRUMBULL

Toward the end of Stanley Kubrick's "2001: A SPACE ODYSSEY"—in that somewhat psychedelic sequence audiences like to call "the trip"—there are scenes in which the camera seems to be speeding through flat corridors having walls made up of multi-colored abstract patterns of light, an effect which we called the "Star-gate" while we were working on it.

Many people have asked me how that effect came about. Kubrick had said that he wanted the camera to "go through something", but nobody knew quite what or how. As a Special Effects Supervisor working on the film I came up with one idea which is derived from some of the work of John Whitney, who, with his sons, has done some incredible things in combining completely abstract optical effects with computerized graphics.

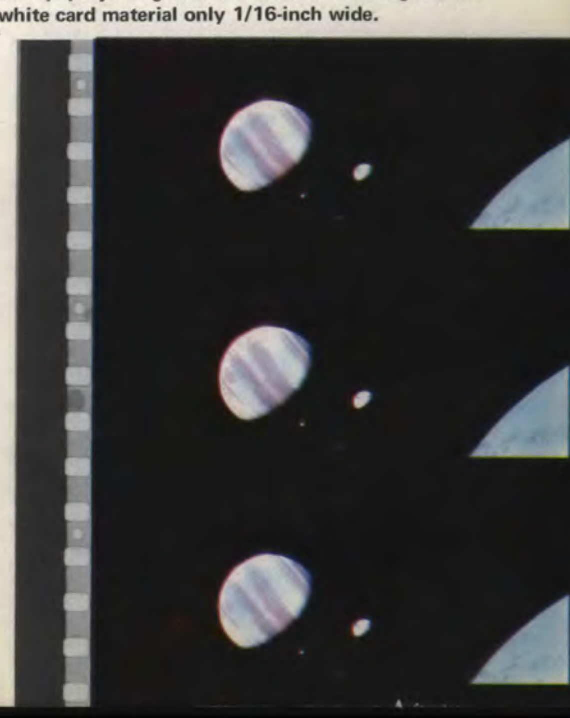
I had just vaguely heard about something he had attempted involving a slit that moved across the frame while something moved behind it in a pattern that distorts in an odd way. I asked myself the question: "Why couldn't that pattern be made to move in depth—in *space*, so to speak?" There seemed to

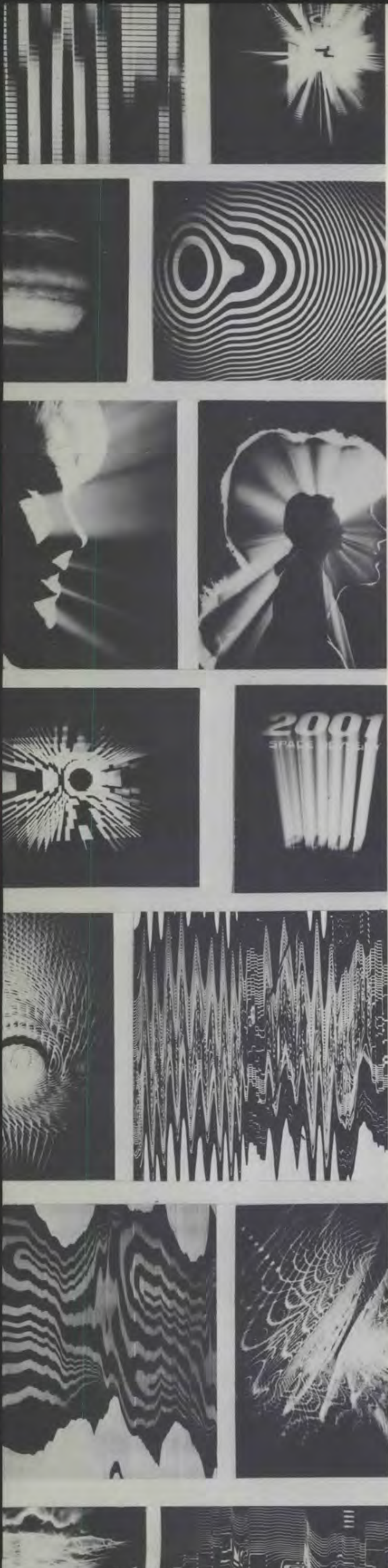
(ABOVE) Frame blow-ups from several of the television spots made for the American Broadcasting Company by Trumbull Film Effects, involving slit-scan projections of the ABC logo. (BELOW) Frame blow-ups from the stunning Star-gate "psychedelic trip" sequence which enlivens the final portion of Stanley Kubrick's "2001: A SPACE ODYSSEY". The effect was created by the author using the slit-scan process which he developed while working as Special Effects Supervisor on that fabulous film of the future.



(ABOVE) The raw material from which Douglas Trumbull created the striking cover for this issue of AMERICAN CINEMATOGRAPHER, utilizing the slit-scan process. He began with nothing more than a high-contrast outline negative of the letters in the CINEMATOGRAPHER logo, then backed them up with various shades of tinted gelatin. (RIGHT) The high-contrast material, thus prepared, was placed on the slit-scan machine and made to rise up and fall back in a sine wave curve controlled by an eccentric cam. The camera recorded the spectacular "rainbow waterfall" of colored light generated from the logo as it travelled down the track of the machine. This is a variation of the same technique used in creating the "Star-gate" sequence in "2001: A SPACE ODYSSEY".

(LEFT) Exposure test for the creation of the planet Jupiter in '2001", utilizing the slit-scan process. The black lines indicate where the shutter was closed momentarily during the test to denote changes of exposure. (BELOW) Frame blow-ups from the final sequence of "2001" showing the slit-scan manufactured planet Jupiter in juxtaposition to other planets. Spherical shape was generated by projecting flat art onto a rotating arc of white card material only 1/16-inch wide.





be no reason why it couldn't, so I decided to try it.

At the M-G-M Studio in England, where the picture was being made, we had a 70mm Oxberry animation stand which was rigged with a Polaroid camera that we used to run tests of animation artwork in register. I stopped the lens of the Polaroid down to about F/45, so that it would have a great depth of field. Then I got together some random *moiré* patterns, slit lines and abstract black and white transparent artwork. I would fit one of these patterns onto the register pegs, start the camera up at the top of the track, open the shutter, and then just sit there and crank the handles by hand, moving the slit across and moving the artwork around and trying out different kinds of effects.

I ended up with a stack of Polaroid pictures, each of which was a separate and fascinating effect. One of the simplest applications of the technique resulted in flat walls of exposed light. When Kubrick saw examples of this he really liked it, and he told me: "Do *that*. Go ahead with it!"

I designed a special rig to shoot these "slit-scan" sequences and started to build it on Stage 3 at M-G-M. We got it about half finished and then, for some reason, we had to vacate Stage 3. So we tore the whole thing down and moved it to another building where we finally got it put together. It involved panes of glass 5½ feet high and 12 feet long, mounted on huge tracks. We had to have large worm gears about 15 feet long, two inches in diameter and weighing 200 pounds, flown in from Detroit to move the camera up and down and drive the panes of glass back and forth in sync. It turned out to be a great, huge, clumsy rig—but it worked.

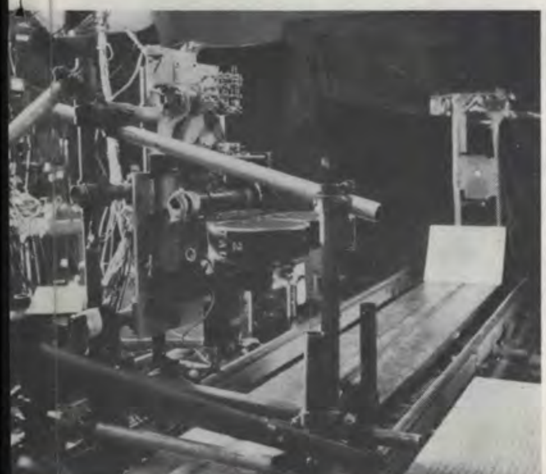
SUMMARY OF THE SLIT SCAN PROCESS

The term slit scan applies to only one form of a general process which would more accurately be called animated streak photography. Streak photography is used primarily in scientific flow and movement analysis, and consists of either extended time exposures or stroboscopic sequence multiple exposures to show changes in shape, direction, or velocity by exposing an entire movement onto a single film plate.

The animated streak photography technique, loosely called slit scan, consists basically of a mechanical or optical method of producing and exposing a controlled image movement onto mo-

(LEFT) A few examples of the infinite variety of design and special effect motifs possible with the slit-scan process. (RIGHT) Artwork being assembled for "psychedelic" Star-gate sequence which appeared in Stanley Kubrick's "2001: A SPACE ODYSSEY" and which was produced by means of the slit-scan technique.

Trumbull adjusts machine he built to "create" planet Jupiter for '2001". Special controls were needed to avoid speed fluctuations, which would have caused uneven exposure.



65mm Todd-AO camera mounted sideways on slit-scan track for shooting horizontal walls of light seen in end sequence of "2001".

tion picture film one frame at a time, each frame containing a complex streak exposure. The synthesis of movement as seen when the film is projected, is created by a controlled incremental change in the image from one frame of film to the next.

The mechanical arrangement of image and camera, as well as the electrical control apparatus, are probably not patentable ideas. However, the application of the streak photography technique to produce images which simulate reality, three-dimensionality, solid spacial relationships, and almost infinite photographic depth-of-field—is a major breakthrough in the creation of motion picture special effects which have heretofore been impossible.

The mechanism is simple. Either the image or object being photographed must move or change in some way relative to the camera during each exposure, or alternatively, the camera itself must move relative to the image being photographed. No matter what the specific relationships are, whatever movement takes place during the exposure must repeat itself exactly for each

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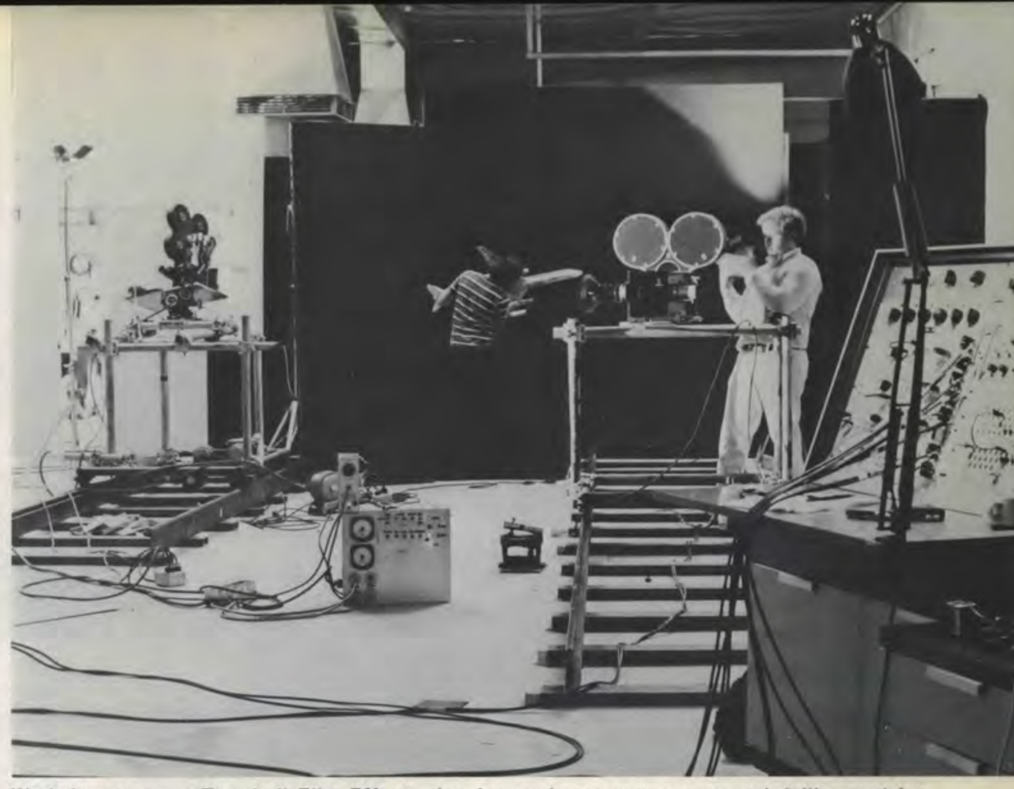
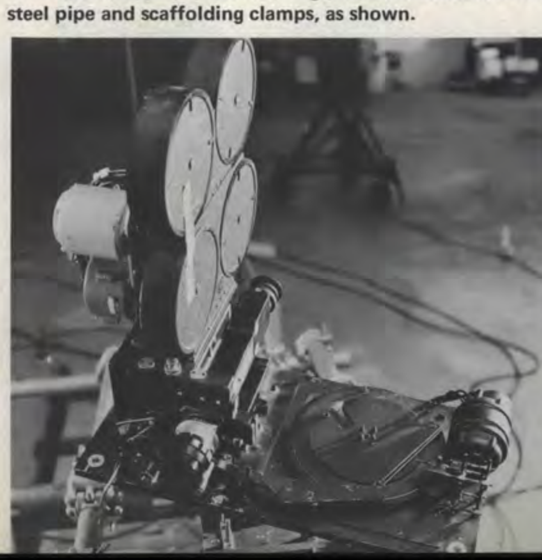
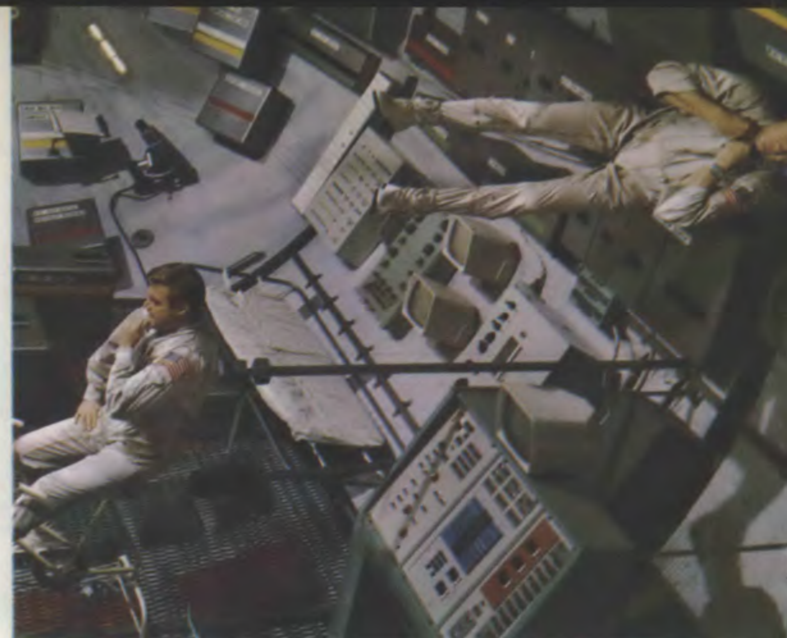


Work in process at Trumbull Film Effects, showing tracks, camera mounts and dollies used for slit-scan and other effects. Artist is painting airplane model matte white so that automatically matched movement can be shot to produce high-contrast, bi-pack matte.

(LEFT) Trumbull lines up automated camera equipped with pulse motor drive system and selsyn-operated automatic focus. Bi-pack shooting allows matted foreground and background elements to be exposed onto the original negative for maximum quality. (RIGHT) Control console for pulse motor system, which is driven by sequences recorded on magnetic tape and can repeat exactly any number of takes involving complex inter-related movements.

(LEFT) 35mm standard Mitchell camera equipped with pulse drive and selsyn-driven focus cam. This camera is capable of copying over a range from 1-to-1 to infinity, using a 28mm Nikkor lens in bellows mount. (RIGHT) Rigid camera mounts and rigs are readily constructed using 2-inch steel pipe and scaffolding clamps, as shown.





(ABOVE LEFT) As the earth turns below, astronauts work weightless outside the Space Lab in a scene from "MAROONED". (ABOVE RIGHT) Astronaut James Franciscus does bicycle exercises to keep fit, while Gene Hackman floats weightless above him in the cabin of the Space Lab. (BELOW RIGHT) David Janssen emerges from experimental Rescue Vehicle X-RV and guides himself toward the marooned Apollo capsule.

(ABOVE LEFT) Members of the "MAROONED" crew set up lights and cameras near the launch area on location at Cape Kennedy. (BELOW LEFT) In the Mission Control Room at Houston Space Center, officials trying to effect a rescue speak to astronauts monitored from space. (BELOW RIGHT) Gregory Peck, playing Chief of Manned Space Flight, conducts a press conference on location at NASA headquarters.

FILMING "MAROONED"

Continued from Page 976

a very few of the backgrounds (Earth, the Moon, etc.) that would later be printed in, so it was a matter of lighting by guesswork with the hope that the light sources could be made to coincide with those of the backgrounds that would be used.

Since the scenes in which the actors appeared outside the spacecraft were relatively wide-angle in scope, it was necessary to mount the lights some distance away and to use a lot of them. To accomodate the long throw, eight triple-deck parallels were set up on either side of the stage, with as many as 15 Brute arcs lighted at one time to simulate the "hard" key source, and a smaller number on the fill side. Very careful goboing was needed to maintain the illusion of a clean single source of light.

The main problem, however, arose from the fact that the blue of the backing was reflected in the shiny face pieces of the astronauts' helmets. If allowed to go uncorrected, these areas would have become transparent in the matting process, so that the backgrounds would have "leaked" through. To couteract these reflections, and thus eliminate the problem, it was necessary to shoot all of these scenes through a pola-screen.

Shooting of the scenes outside the spacecraft was further complicated by the fact that the actors had to be suspended by wires in order to simulate their weightless condition. The wires were, of course, painted a dull blue so that they would blend in with the blue screen background. But, even so, a great deal of care was needed in lighting to make sure that the wires would not become visible.

The weightless effect inside the relatively large space laboratory was again simulated by suspending the actors from wires, but in this instance the scenes were shot from below so that the actors' own bodies would block out the wires.

No such solution to the weightless problem was possible within the close confines of the space capsule, however. In this case, four Chapman cranes were pressed into service. Each of the three astronauts rode "weightless" on his own individual crane, while the camera was mounted on the fourth. It goes without saying that these scenes had to be rather tightly framed to avoid having the bases of the cranes pick up in the shots.

Aside from the scenes showing maneuvers of the various spacecraft, the most ambitious sequences in the film were those shot in an exact replica of the NASA Mission Control Center at Houston, which was constructed on the sound stage at Columbia Studios. Production designer Lyle Wheeler had spent several weeks in Houston researching the layout, and he designed the set to precise specifications, which included duplicating the maze of consoles down to the last authentic detail. In this he was aided by the Philco-Ford Company which made available practical telemetric gadgetry valued in excess of a million dollars.

In this complex setting the astronauts marooned in space are seen on giant wall-screens as well as on individual monitors at the various consoles.

"In shooting the material of the astronauts in space to be shown on the screens and monitors at Mission Control, I tried to make it look very 'documentary'—in other words, as bad as possible," comments Fapp. "This is in keeping with the way such scenes actually look coming back from space. We used very flat lighting, without any character at all. The Special Effects people took it from there and messed it up even more in the printing. They may even have overdone it—but the result looks very real."

The scenes appearing on the wall screens were put there by means of standard rear-projection, but those shown on the monitors were run through a closed-circuit television system. Photographing them from the tube called for special alterations of the film cameras (included a shutter angle reduc-to 140°) in order to avoid picking up the flicker bar.

The lengthy production schedule for "MAROONED" included three weeks of shooting at Cape Kennedy. The company of nearly 100 cast and crew from Hollywood worked long and tough hours, night and day, to film some of the more spectacular (though terrestrial) footage for the picture.

In the script, the astronauts are marooned in space as the result of some mechanical failure of their spacecraft. A giant effort is mounted to attempt their rescue and this coincides with the arrival of a fierce hurricane that strikes the Cape. The decision is made to send the rocket hurtling up through the "eye" of the hurricane in order to avoid critical delay.

In describing the shooting of this sequence, cinematographer Daniel Fapp observes: "The script called for a lot of wind and rain, with the effect depending mainly on the wind. The sequence

Director John Sturges (next to camera) explains action for upcoming scene to actors playing astronauts on the set of "MAROONED". Great attention was paid to technical authenticity,

was shot at night and there's nothing much that you can show blowing in the dark except the clothing of the actors. We rigged six big jet wind machines and just blew the hell out of everything. We managed to get one of the big rain towers down there to provide plenty of rain to blow around, although we were handicapped by local regulations in trying to light the rain to show up properly. We had planned to erect a high parallel with Brutes on top, but they wouldn't permit us to put men up there to operate them. I finally got one of those big cranes that they use for lifting and mounted two 10K's on it. That really wasn't enough light, of course, but somehow it worked out pretty well."

Comparisons will inevitably be made between "MAROONED" and Stanley Kubrick's extraordinary "2001: A SPACE ODYSSEY"—but there is really little basis for comparison, aside from the fact that they both deal with astronauts exploring deep space in the not-very-distant future. Whereas "2001" is a *tour de force* of superb special effects with major emphasis on the ultra-sophisticated mechanics of interplanetary travel, "MAROONED" concerns itself primarily with the human element: the astronauts themselves, their wives and the unsung heroes of the ground crews that support spae flight.

Nevertheless, by the very nature of its subject matter, "MAROONED" has been unable to avoid emerging as a spectacular motion picture—which is all to the good, because, after Apollo 11, it has a mighty tough act to follow. ■

*TLC TREATMENT

Continued from Page 968

As if the huge task were not enough in itself, a slowdown in procedure had to be made up by the crew. The time was accounted for in the two planes bringing the film at different times and in the procedure after arrival.

When they arrived at the Lunar Receiving Laboratory, rock boxes and other things in that particular area had to be removed before the bags could be opened to begin the work on the films. By the time they were allowed to begin handling the film, the crew had been on duty 20 hours and judged too tired to handle what must be some of the most valuable film in the world.

Besides the intricate decontamination procedures, the lab established its own sensitometric characteristic curves of the films the astronauts used and built their own chemistry for the processing. Other considerations are how the astronauts used the film and the spacecraft's radiation, pressure, temperature and humidity, all of which could change processing techniques.

All of the lab's problems were accentuated by an accident which fortunately occurred pre-processing instead of during. Taking painstaking precaution with the precious film, the lab had tested decontamination procedures for two years to develop a reliable system. It worked perfectly until three days before the film was to arrive. Then a roll of film was ruined by a partial liquefying of the gaseous sterilizing solution. A small umbrella was constructed inside the Autoclave to prevent it happening again.

The exacting and sometimes exasperating work by Underwood's group will reap rewards for some time to come. Not only do they deserve a special salutation from the world's press, but from the scientists who will be kept busy studying the photographs for some time. The stills made with the Hasselblad cameras will be blown up hundreds of times as will tiny portions of them so that minute details can be studied.

The expectation of excellence in Hasselblad still photographs is so great that when a condition of micro-mottling occurred during a processing test of black and white film, the lab's experts re-built the entire chemistry for processing. The scientists would not accept the photographs in any condition but perfectly sharp. The combination of Hasselblad and laboratory precision has given scientists of different disciplines reliable, important study material since 1962. ■

NEW A.S.C. MANUAL

Continued from Page 953

ways been essential for successful motion picture photography. Not too many years ago, more than one top-flight cinematographer carried a small notebook, or cards in his wallet, on which he had written the information he considered vital to his work. Happily this sort of hit or miss system is no longer necessary thanks to the AMERICAN CINEMATOGRAPHER MANUAL.

The manual began in 1934 as *The Cinematographers' Book of Tables*. It was compiled and privately published by the late Fred Westerberg. The idea was later greatly expanded by Jackson J. Rose, ASC, into *The American Cinematographer Handbook and Reference Guide*. It was an instant success. During World War II a plagiarized translation into Japanese was discovered on a dead Japanese cameraman and was subsequently given to Rose by the American serviceman who had found it.

In 1960, after Rose's death, the A.S.C. issued a greatly enlarged and revised edition as THE AMERICAN CINEMATOGRAPHER MANUAL. Coincidentally, Miller and Strenge were the prime movers behind the re-vitalized manual. More than twenty-thousand copies of this book went into world-wide circulation. By 1966, it was necessary to issue a second edition, which is now no longer available.

The current edition contains more than 600 pocket-size pages of concise, practical, informative text, tables, charts, diagrams, drawings and listings of all the latest production equipment and filming techniques currently in use. It has been aimed at theatrical, non-theatrical and television cinematographers shooting 16mm, 35mm or 65mm anamorphic or spherical motion pictures in any aspect ratio either in color or black and white. While basically for cinematographers, it will also benefit anyone engaged in film production, such as film editors, lighting technicians, sound mixers, cinema students, directors, producers and members of the Armed Forces engaged in filming activities. In fact, all photographic branches of the United States Armed Forces have included the manual in camera kits since the days of World War II. Editions of the manual are currently in front line service with the Army, Navy, Air Force and Marine Corps in the Vietnam War.

Several all-new features have been added to the manual. Briefly, a few of these are:

A camera trouble-shooting guide covering all types of motion picture cameras—helpful in locating and correcting some of the more common causes of camera malfunctions.

Comprehensive information of the new front projection technique.

A useful glossary of photometric terms compiled especially for the cinematographer.

New and up-to-date data (including threading diagrams) on 16mm, 35mm and 65mm camera equipment.

Technical information on the newly introduced fast 16mm, 35mm and 65mm color films.

Data on the latest zoom lenses and such special lens attachments as the "dynalens."

Detailed information on lighting equipment, particularly tungsten-halogen or "Quartz" lights.

Dictionary of motion picture terminology in English, German, French, Spanish and Italian.

Up-to-date information on special effects cinematography including optical printers, traveling-matte systems, sodium light, blue screen, etc.

All of the above examples represent but a small portion of the individual information contained in the new manual. ■

LIFT-OFF AT CAPE KENNEDY

Continued from Page 970

three major networks, the latter by means of a 500-inch focal-length lens tracking facility at Patrick Air Force Base.

Following the completion of each mission, a documentary film is prepared for NASA records. At the same time, 65mm footage is processed for use by commercial motion picture and documentary producers who may desire such wide-screen material. Still photos, invaluable in engineering and historical documentation, also are provided for the communications media.

During the Apollo 10 mission, Technicolor crews utilized nearly 45,000 feet of original motion picture film, and in a four-hour period, turned out well over 5,000 still prints.

Some surveillance cameras operated as slowly as two frames per second while other high-speed cameras exposed 500 or more frames per second, stretching time so that the eye could pick up every detail of an important action. Cameras could be placed in areas hazardous to humans yet, properly protected and remotely started, were able to record information unobtainable in any other way.

In addition to immediate launch support activities, the Technicolor personnel in Florida operate one of the finest optical shop facilities in the Southeastern United States, plus a full-scale motion picture production unit which turns out safety, documentary and training films for both NASA and the Air Force.

The company's role in documenting the historic lunar flight was not limited to filming of the launch. NASA also awarded Technicolor a contract to convert into motion picture film all color and black-and-white television transmissions made by Apollo 11 to earth from the moon.

Master television tapes of the historic moon flight and landing were flown from Manned Spacecraft Center, Houston, to Technicolor's Vidtronics Laboratories, Hollywood, where the actual conversions were made. NASA officials there supervised editing of a half-hour film to be distributed worldwide while the flight was still in progress.

Television transmission from the moon's surface was in black and white. Technicolor's experts used an electronic beam recorder for the film conversions, providing the highest fidelity available

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TELEVISION ROBOT

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number, and then, at the appropriate time, depresses an access button which locates the new image and throws it on the screen. Click stops enable operators to preset counters in the dark.

In the Apollo 11 coverage, the actual accessing process was projected on the screen for an interesting "computerized" effect. The viewer saw the blur of whirring image elements as each projector sought out its pre-selected frame. Image elements would thus form in sequence on the screen in the manner of the spinning symbols in a "one-arm bandit" slot machine.

Three operators manned the console, keeping three or four of the system's ten projectors in almost constant use to create the composite images.

Random access film library

The basic image library is stored on single frames of 16mm motion picture film. Although the maximum storage capacity is 9,999 single-frame images per projector, only a portion of the capacity was needed for the Apollo broadcasts. Each projector had a 100-foot reel of identical film. Each reel had 3850 frames with all frames numbered. The use of multiple 16mm projectors with identical storage permitted smooth accessing at the high rate of 30 frames per second.

Graphic material included words, phrases, diagrams, trajectories, maps, pictures, landing and splashdown sites, and other images which could be displayed and run through at various rates, or reversed for discussion. Combinations of words and phrases could be called up to the screen in various arrangements to serve as titles, marginal notes, or messages from space. More than $2000 was spent in typesetting alone on the system's "vocabulary."

Animation effects were achieved at low frame rates rather than at cine speed. Because of the flickerless projector pull-down, a globe could be made to rotate a full 360 degrees in "slow motion" in the short space of 30 frames. A variable timer feeding into the projector's frame-rate control, permitted animation to match the timing of actual events.

Operators at the console could create, for example, a turning earth above which a space vehicle appears at the proper point, moving. A dotted line might trace the path of the vehicle, and the word "Tasmania" appear at the correct moment.

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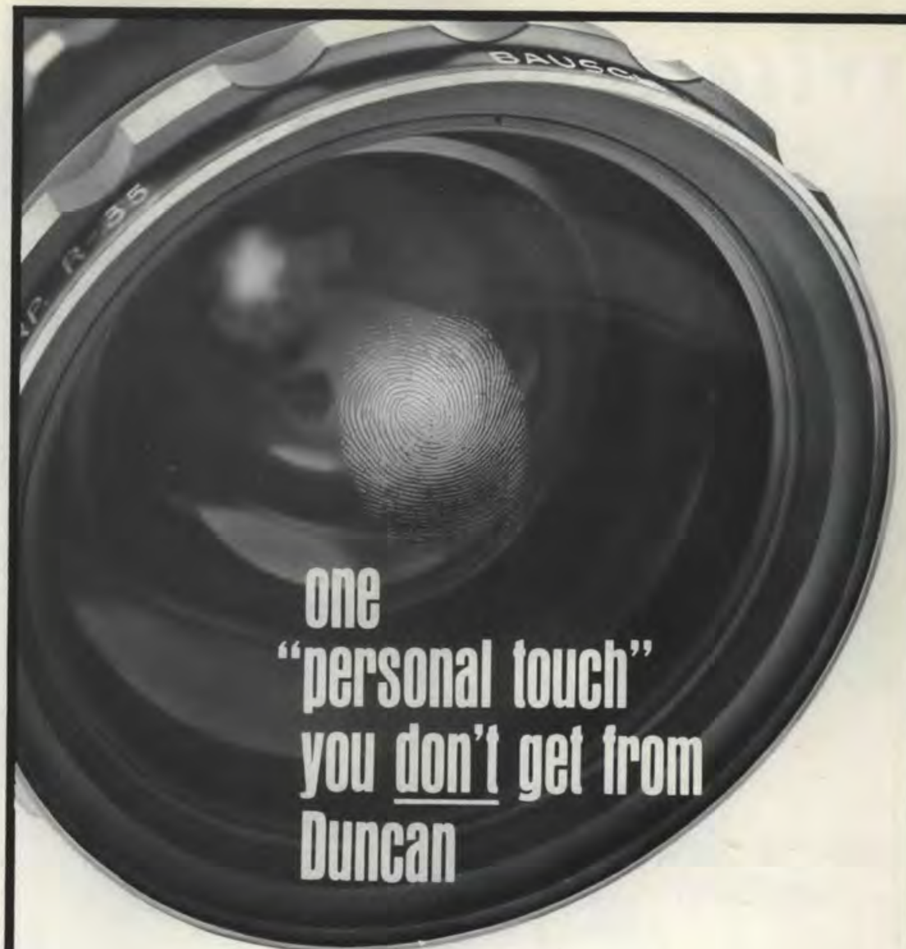

THE SLIT-SCAN PROCESS

Continued from Page 1001

frame of film—except for the incremental change needed to produce cinematic movement.

More specifically, if during one frame of exposure a hypothetical image moves from point A to point B, the exact same exposure may be made by movement from B to A. By this means, recycling time between frames is eliminated, and the frame by frame sequence is A to B, B to A, A to B, and so on. The incremental change to produce motion takes place between frames, and is usually a small fraction of the total A to B movement, the size of the increment determining the speed of cinematic movement.

The following ideas show the progression of the streak photography technique to produce a photographic image of something that does not actually exist; a point light source moved during exposure produces a line in space—an intermittent light produces a dotted line. A line moved in space produces a plane of exposure—variations in the appearance of the line produce a pattern on the plane. Variations in the pattern of the plane produces a solid of varying density and pattern. Variations in the shape of the plane itself, produce a solid of complex and variable shape.

Obviously, these examples are extreme simplifications of the basic idea—for instance, an extremely complex spacial structure of lines and points may be created by the interrelated movements of the points of light on a back lit moire pattern. Complex multiple planes may be produced in the same way, depending upon the construction of the moire. An almost infinite plane may be created by moving an illuminated image behind a very narrow, long slit opening, while the entire mechanism moves toward the camera—we call this the slit scan.

A great variety of effects may be achieved by moving a flat surface, upon which are projected variable images, through space during the exposure—thus creating a solid effect from a flat image.

The permutations of movement relationships, exposure time, shapes, colors, etc. are endless, but the mechanism needed is fairly simple and adaptable to most situations.

There are usually only two axes of movement: (1) movement of the camera relative to the image, and (2) movement and change of the image itself. These movements are directly linked through a differential mechanism which provides the incremental displacement between the two, thus creating the cinematic movement. Since the camera is usually the least bulky part of the whole mechanism, it moves relative to the image via a simple track and gear system. The image is usually produced by projections or other light and pattern producing mechanisms on a plane relative to which the camera moves. Since the distance between the image and camera varies during the exposure, another mechanism is incorporated which automatically keeps the camera lens focussed upon the image plane at all times. Therefore, the image on one frame of film may include an infinite number of focal distances at once, keeping the image sharp from the most extreme foreground to infinity.

For consistency and evenness of exposure, all movements must be smooth and repeatable. High precision bearing tracks, anti-backlash gearing, synchronous motor drives, and selsyn links are used for this purpose. Synchronous sequencers and timers are used to control the overall system.

Since this technique deals with an accumulated exposure, only a fraction of which exists at any single point in time, light meter readings are relatively useless, and a desired exposure can only be obtained by a trial and error process. Otherwise, exposure is the same as normal photography, being dependent upon image brightness, lens aperture, film sensitivity, and total exposure time.

Description of Slit Scan Camera Mechanism

The slit scan camera mechanism incorporates a normal motion picture camera equipped with a stop motion motor, along with various selsyn motors and timers, to produce the streak photograph frame by frame as mentioned in the summary of the slit scan technique. The most important part of the mechanism is the motion picture camera. The normal shutter mechanism within the camera is taken 180° out of phase so that between frames in the stop motion sequence, the shutter remains in the open position. The exposure is then controlled by the auxiliary diaphragm-type shutter in front of the lens which is activated by the main sequencer.

The focus of the lens is controlled by a cam, which is driven by a slave selsyn linked with the main drive system. The camera and its mechanisms are driven along the track via another slave selsyn, which is also controlled by the main drive system. On the camera dolly are microswitches which determine the

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QUIET CAMERAMEN

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had only a Bolex motion-picture camera and an old Speed Graphic. With this equipment he covered almost all events that needed recording.

Said Emmerson, "We did not have the sophisticated equipment available today. We had to make do with available equipment, and there wasn't much at that time."

He said that one of his first assignments was shooting footage of an A-20 Douglas bomber taking off with the aid of liquid fuel rockets attached to the engine nacelles. This was the forerunner of the jato assist system.

"In place of the sophisticated time-lapse equipment now available, I had to use a Sept camera rigged up with a solenoid to record test results on various gauges and dials." Later, Emmerson equipped his one-man laboratory with a Cine Kodak Special, and, as the years went by, with the usual complement of standard, professional 16mm equipment, and a 32-man staff.

"Today, we have what we like to call 'instant cameramen.' They are all loners; they can shoot virtually anything under the most trying conditions—but always, they are quiet cameramen who are almost invisible when shooting an assignment."

He declares these habits are so strong that, in the past, even when assigned to Cape Kennedy during a launch, the cameraman worked alone. He depended on himself for both sound and picture; he never used an assistant. The whole operation was usually a one-man task, featuring speed of movement, self-reliance, independence, and all-around expertise.

Many of the assignments emanating from the Jet Propulsion Laboratory are before the fact, as, for example, the complicated assembly of the spacecraft, and subsequent testing. But during a launch the cameramen become press photographers and must record events as they break under uncontrolled conditions, with no retakes. And all this performed quietly and surreptitiously with few lights and no tripods.

"But events at the laboratory for the working press are entirely different," said Emmerson. "We have here a large auditorium with lights, power, and even a 16mm Mitchell with 1200-foot magazines for press use when necessary. The light level, 300 foot-candles, is high enough to assure well-exposed color footage and there are plenty of mikes, reflectors and other equipment available

Cameraman Gregoire shoots 1:10 scale model of Mariner spacecraft for sequence directed by Everett De View, supervisor of motion pictures, stills and instrumentation at JPL.

for the news media. The press can simply plug into our system and do the job with great dispatch."

Asked about his greatest achievement in the picture business, Emmerson said, "The moon pictures, of course. While these are a far cry from conventional motion pictures—in fact, nothing but stills—they were the most thrilling to see as they came in straight from the moon's surface. Here we were, a quarter-million miles away, watching the lunar surface, never before seen in such detail by anyone. That was the greatest kick.

"But, more than that, there is an overall achievement of another kind. That is, recording the events that happen here, quietly, surely and efficiently and playing a small part in this era of the camera; this era of seeing.

"The remarkable thing is that we have the calibre of men that we need. At best, our cameramen are intruders, yet they must be unobtrusive and keep out of the way. It takes a special breed of cameraman to cope with such situations. He must get along well with people, especially at times when scientific personnel must make rapid decisions, in minutes.

"Of course it is difficult to do creative work under such awful lighting conditions. But our men do it and I'm happy to work with such dedicated cameramen," he concluded.

We left his office, quietly, unobtrusively. ■

THE SLIT-SCAN PROCESS

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positioning and reversing of the entire camera mechanism via the automatic sequencing mechanism.

The camera faces towards a plane of glass at the end of the track and remains focused on that plane at all positions along that track. Directly behind this plane of glass is another sliding plane of glass which is driven by a slave selsyn, controlled by the main drive unit. The main drive unit consists of a reversible, ¼-horsepower, synchronous motor, a solenoid type brake on the motor and a master selsyn driven by the motor. The master selsyn drives all of the slave selsyns at the camera dolly, the camera focus and the sliding glass plane.

During the exposure of one frame of film, the camera dolly traverses a length of track approximately 12 ft. and, in this time, the focus selsyn provides a cam rotation of approximately ¾ of a rev., which keeps the lens focused upon the glass plane. In addition, the selsyn driving the sliding glass plane provides a movement of approximately 10 inches. At the forward and back positions on the main track are cams which trigger the microswitches on the camera dolly which, in turn, operate the main sequence control unit. The sequencer stops the main motor, engages the brake, closes the shutter, advances the film to the next frame, provides the incremental advance to the sliding glass frame, restarts and reverses the main motor and re-opens the shutter.

Using a 35mm. lens on a 65mm. camera, the area covered in the back position on the track is roughly 14 ft. in width. At the closest position on the track, the area covered is roughly 4 inches. At this point, the front lens element and shutter mechanism are extremely close to the glass plane and, for this reason, the brake has been added to the main drive motor to stop the camera dolly before it coasts into the glass. Emergency overrun microswitches are also provided to cut off the main power supply in case the camera dolly overruns its normal stopping position. During the normal sequence of photography, shooting may be stopped at any time by turning off the auto restart switch which allows the camera to carry on its normal exposure until it reaches the microswitches, at which point the sequencer will provide all of the normal sequences including film advance, artwork incremental advance, etc., without restarting or opening the shutter. At this point, the sequencer stops and waits until the auto restart switch is turned to the 'On' position. In this way, various checks of the camera and other functions may be made during a shot and lights may be turned on since the shutter remains closed during this time.

In slit scan photography, the entire shooting area must be kept completely dark, except for the back-illuminated artwork. A track light is incorporated in the system which is basically a darkroom safe light which comes on only during the time that the shutter is closed. This allows various checks to be made on camera positioning and artwork during shooting.

The artwork is made of various types of light transmitting materials such as color transparencies, black and white transparencies, and colored celluloid gels, and is attached to the sliding glass plane. On the static glass plane is a very narrow slit opening, through which only a small segment of the artwork can be seen at any one time. With the camera in its closest position, the slit is positioned at a point just slightly outside the frame area seen by the camera, so that as the camera moves away from the glass, the slit comes into view and when the camera is in the farthest back position, the slit is in almost exactly the center of the frame. During this movement from front to back positions while the camera shutter is open, the artwork is sliding on the glass frame and is therefore being exposed behind the slit as the slit image travels across the film plane. In this way the artwork is literally scanned onto the film, creating a receding plane of exposure. Since the camera is traversing a distance of 12 ft. and the artwork is only traversing a distance of 10 inches behind the slit, this has the effect of stretching the artwork over the 12-foot distance. To create the effect of movement along the plane of exposure, the incremental change is applied between each frame which displaces the position at which the artwork intersects the slit. Different amounts of incremental change produce different apparent speeds of movement and multiple slits provide the effect of multiple planes of exposure.

Other effects can be produced by using moire patterns interacting between the static glass plane and the sliding glass plane.

Since widely varying speeds may be called for in the apparent motion of the slit scan effect, the incremental advance is controlled as a function of time rather than as a function of gear ratios, so that the art advance timer may be set at any amount of time depending on the speed desired—more time producing a greater

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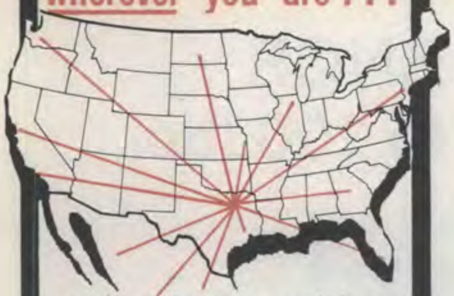


TELEVISION ROBOT

Continued from Page 1011

In the Apollo 11 mission, the approximate start time of events was known in advance, as was the rate of development of the events. Operators of the projector system were therefore able, as news reports came in from Mission Control in Houston, to set up for real-time graphic coverage. Any change from the scheduled timing of actual events could easily be accommodated by the projector system's variable timers.

Projectors may be accessed singly or simultaneously in any desired combination. Accessing is controlled by digital pulse circuitry, electromechanical memory and digital-analog search system. Use of high-contrast black and white film eliminates the possibility of overlap lines when two or more projectors are being used to compose a screen image.

Development of the system

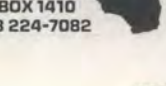
Doug Trumbull started work on the system just six weeks before the Apollo 11 mission was scheduled to take place. CBS wanted a highly flexible means of handling titles, words and phrases. When Trumbull found that the off-the-shelf L-W projector embodied features he had planned to design into a custom unit, he expanded his original thinking to include the wide range of graphic effects used during the Apollo newscasts.

Besides developing the technical system, Trumbull also conceived and executed the entire graphic presentation in the same six-week period. All work was done in Studio City, California.

After completion, the system was dismantled and shipped to New York, where it was reassembled and checked out on a round-the-clock working schedule during the week before the mission.

CBS named the system HAL 10,000 after the computer in the film "2001: A SPACE ODYSSEY." The figure refers to the image-storage capacity of a single 16mm projector in the system.

Scaled-down versions of the system will later be made available to television stations throughout the country, Trumbull said. CBS, he added, already plans to use such systems to enhance newscasts, weather reports and other programs. ■



LIFT-OFF AT CAPE KENNEDY

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in the world today, according to Joseph Bluth, vice president of the Vidtronics Division.

The conversion to motion picture film allows much wider use of the historic pictures from outer space than would be possible by videotape. Technicolor made the first conversion to color film of color tapes transmitted from outer space during the Apollo 10 flight as an experimental project for NASA.

To follow through on documentation of the Apollo 11 project, NASA assigned three Technicolor crews to provide full Panavision film coverage of astronauts Armstrong, Aldrin and Collins from their initial "coming out" press conference in Houston to the Presidential banquet at Los Angeles' Century Plaza Hotel.

The Technicolor crews were "leapfrogged" between Houston, New York and Chicago for the filming—with two crews covering the finale in Los Angeles the night of August 13. ■

SPECIAL PROGRAMS PLANNED FOR 106th SMPTE CONFERENCE

The 106th Conference and Equipment Exhibit of the Society of Motion Picture and Television Engineers will be held Sept. 28—Oct. 3, at the Century Plaza Hotel in Los Angeles, CA. More than 60 papers will be presented on the Conference Program, sixteen in the area of television. The papers range in content from the latest in automated videotape editing to the newest color television camera systems. The papers will be presented in three sessions held all day Tuesday and on Wednesday afternoon.

In addition to the television program there will also be sessions devoted to Instrumentation and High-Speed Photography, Laboratory Practices, Applications and Technology, Theater Presentation and Projection and a special symposium on Test Films. On the last two days of the Conference a Symposium on 8mm Film Production and Techniques will be held. The symposium will feature 12 invited papers given by experts in the field of super 8 film.

During the entire week of the Conference an Equipment Exhibit featuring over 90 booths will be open to Conference registrants. The exhibit will include the latest in motion-picture, television and processing equipment.

THE SLIT-SCAN PROCESS

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amount of incremental advance each frame. The film advance timer gives a controlled one-second pulse which is required to advance the film one frame. Other timers may be added to the circuit to provide more complex advancement or incremental change in the image. Extra slave selsyns may also be added for this reason.

Since this streak photography process deals basically with the idea of image movement during exposure, any photographical image or object may be used to create a streak image effect and the type of effect created will depend upon the manner in which the image is moved relative to the camera. Therefore, the arrangement of the camera, dolly, track, and artwork plane may be altered to any number of different combinations. For this reason, master and slave drive selsyns were chosen for ease of adaptation to different setups.

The film advance and art advance timer start switches must be in the 'On' position to complete the microswitch-operated circuit which energizes the timers.

The motor and brake contactor switch must be in the 'On' position to complete the circuit which energizes the contacter, which in turn, provides power to the main motor and main motor brake. This switch may be used to stop progress of the camera dolly at any point along the track.

The auto restart switch completes the circuit to restart the main motor at the end of the cycle between frames.

The emergency stop switch on the camera dolly is wired in series with the motor and brake contactor switch and is useful for checking the camera focus at points along the track as well as an emergency stop in case of trouble.

Functions of the three microswitches on the camera dolly are as follows:

1. To disconnect the main camera drive.
2. To start the cam sequencer unit.
3. To reverse the direction of dolly movement.

The main motor is a single-phase, ¼-h.p. synchronous motor.

The art advance motor is a capacitor inductance, 1/75th-h.p. motor.

The art and film advance timers are normal darkroom timers incorporating a continuous running synchronous clock motor and provide a timed pulse depending on the dial setting whenever the timer start circuit is energized.

The cam sequencer motor is a 1/75thh.p. capacitor inductance motor equipped with a disc type electric brake.

The cam sequencer unit consists of the cam motor, the cam motor brake, and a set of five rotary cams which activate microswitches to perform various functions during the cycle between frames.

The auxiliary shutter is a standard diaphragm type still photography shutter, with an internal diameter sufficient to cover the front element of the motion picture camera lens.

The shutter solenoid is a small slug type D.C. solenoid which activates a normal still photography cable release to operate the shutter.

APPLICATIONS OF SLIT-SCAN BEYOND "2001"

Our main problem in creating the slit-scan effects for "2001: A SPACE ODYSSEY" had nothing to do with the machine we built, because that worked just fine; it had to do with the actual artwork.

Stanley Kubrick was very concerned about what would be seen in that sequence, and with good reason—so we went through a great deal of experimentation to get the correct visual patterns.

One of the things we tried involved pure texture and the result looked like giant carpets going by. When Stanley saw it, he said: "That looks too much like carpets going by." So we junked it.

We built a huge opal-glass light board about 6 feet wide and 8 feet long to use in building up the artwork. We got a huge roll of acetate and stretched it across the light board as a base for the materials we would use. These materials included high contrast Op-art paintings, *moiré* scientific kits and just about any other kinds of patterns we could find.

I also put artists to work making my own *moiré* patterns and designing special curves and loops. One of the most interesting techniques of creating artwork to shoot on the slit-scan camera involved a return to shooting with the polaroid on the animation stand. I would take a pattern and then, with the slit abstracting it onto polaroid, create new weirdly exciting patterns. For example, a high-contrast photograph of a printed circuit, when run through the slit-scan process, would become quite a different design, an abstract pattern only vaguely suggestive of a printed circuit. Even a straight pattern of concentric circles could be distorted by the slit to become an intricate Op-art design—something that would be very difficult to draw or paint. We also used enormously blown-up electron micro-

photographs of molecular structures and crystal patterns that resulted in very attractive designs.

Using the slit-scan itself to make artwork for the final slit-scan sequences, we would shoot a great many designs on 4 x 5 Polaroid material. Then we would select about 100 of these and paste them all up together and re-photograph the combination onto a single large high-contrast negative. This would be combined with a lot of other high-contrast negatives to build up a huge mosaic.

Color was added by cutting sheets of colored plastic into shapes to match segments of the design. In each slit-scan exposure the camera traveled a distance of about 15 feet from the farthest point to the nearest point. The vertical slit creates a plane of exposure 15 feet long, and it is exactly the equivalent of shooting a wall 15 feet long from a distance of about one inch from the wall. The odd thing is that during the time the camera moves that distance, the artwork, which is behind the slit, has moved only 4 or 5 inches. Optically, therefore, you have taken a very small segment of artwork and stretched it over a long distance. This optical stretching results in a very streaked effect, so that even a single frame of film (which is a very static thing) looks like it is going very fast. When shooting a piece of artwork 12 feet long and multiplying that by the ratio of 5 inches to 15 feet, you are essentially traveling over a piece of artwork that seems to be many, many yards long—which is why it is possible to get such long takes.

In creating the "Star-gate" effect, there would be one wall on one side of the frame and one wall on the other (or above and below), each photographed with a separate exposure. It was not possible to shoot two walls at the same time because of the angle at which the camera has to shoot the artwork.

It was necessary, therefore, to make two exposures for each of the "Star-gate" scenes. In some cases we used two completely different pieces of artwork. At other times, we would use the same piece of artwork, flopped, with the colors changed. This produces an odd effect that seems like a mirror-image, but it isn't really that. The two exposures don't actually match up, even though the images are symmetrical in form.

The slit-scan machine I built for "2001" was absolutely enormous. The whole thing was constructed of heavy structural steel and sat about two feet off the ground.

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Kodak

THE SLIT-SCAN PROCESS

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Since then I have built a much more sophisticated machine. It is much lighter and more compact, although the track is much longer than that of the first machine. It has smaller panes of glass, automatic follow-focus and the main elements are interlocked by means of pulse motors which are quite powerful, absolutely positive and much more efficient than selsyns.

On recent projects I have been using the slit-scan process in much the same way that I employed it for "2001"—and that is basically with the camera on a track moving toward a pane of glass onto which various kinds of material have been pasted. In the series of promotional spots which we recently completed for the American Broadcasting Company, the material used was simply a series of little ABC logos, all photographed through the slit. In one of these spots the letters of a circular logo turn into translucent tubes that look like they're made out of plastic. They have perspective and appear to be solid, three-dimensional objects. But they have no physical structure at all, because they're created from pure light.

In another of the ABC spots the camera seems to be rushing between flat planes of multiplying logo designs, very much like the "Star-gate" sequence from "2001". In yet another spot I simply took a line version of the ABC logo, photographed it flat to the camera, but stretched it on every frame so that it appears to be about a foot deep.

A similar technique was used in shooting the cover photograph for this issue of AMERICAN CINEMATOGRAPHER. It started with an outline version of the CINEMATOGRAPHER logo, each letter being backed up with a different color. Then, using the pulse motor-driven rig, the typography was stretched and made to rise up and then fall back down in a sine wave curve generated by an eccentric cam as the camera approached it.

A quite different technique from that used in the "Star-gate" sequence was the application of the slit-scan process employed to create the planet Jupiter for "2001: A SPACE ODYSSEY". Several painters had tried to paint Jupiter, but none of them was able to really articulately paint a perspective change around the edge of something spherical—the way clouds, for example, might change in shape, color and tone.

What was needed was a way to transfer a flat painting to a sphere, so as to give it that accurate perspective. I decided to use a variation of the slit-scan process to get the effect.

Starting from scratch, if you want to make a line on a piece of film, you simply take a point of light and move it through the frame. If you have a line already generated and you traverse it through the frame, you can create a plane of exposure. Creating Jupiter was based on the principle of the lathe, in that if you have a semi-circular line of light mounted on a pivot so that it goes around in a circle, it will form a complete sphere on the film.

The line in this case was formed by a very thin piece of paper, trimmed down with a razor blade to a width of 1/16 of an inch and pasted onto the edge of a disc of black aluminum. A flat painting of Jupiter's surface (in color transparency form) was projected onto that little thin line of paper, so that only a very slender fragment of the painting was reflected at any one time. But as the whole machine rotated, the line traversed around and the projected picture traversed across the line simultaneously—just as the flat pane of glass traverses behind the slit in producing the "Star-gate" effect.

We wanted to reproduce the banding that extends around the planet, as well as the spot that is called "the Red Eye of Jupiter"—a sort of oval-shaped reddish area which we know exists on the face of the planet. I painted the Eye in realistic colors and textures, but in a perfectly circular form, knowing that when it was projected onto the spherical "surface" of Jupiter it would be stretched into an oval shape. As the machine rotated in a full 180° arc, the projected transparency moved only 90 to 100 degrees, which means that the image was stretched around Jupiter, giving a very new feeling to the painting. It became sweeping, as if there were terrific wind forces about the planet.

That was probably one of the first uses of slit-scan to create something that didn't look transparent. I could have continued the slit all the way around to show simultaneously the front and back surfaces of Jupiter, but in this case I only went 180 degrees, so that the planet would appear solid. The most pleasing thing about the result is that nobody has ever questioned that it was anything but Jupiter. The fact is that the very best actual photographs ever taken of Jupiter are very bad. They're extremely fuzzy and you can hardly see any distinguishing features. In that respect, I had very little to work with.

There are almost limitless possibilities to the use of the slit-scan process in cinematography, but many people think of it solely in terms of creating something like a light-show. I feel that a light-show, per se, is a pretty aimless approach to any sort of dramatic effect. But just by using the method we employed to create Jupiter, you can develop many other spectacular things that don't actually exist.

I'll be using this and other applications of the process in a picture I'll be starting quite soon with James Coburn called "MAXIGASM" which will require the creation of very super-realistic natural phenomena, including things like the *aurora borealis,* heat lightning, sheet lightning and different kinds of fire balls. The story takes place in the future and these weird phenomena that are going on all the time are just part of the environment. They won't be treated as featured effects, but simply as things that are happening in the corner of the frame or in the background.

There will also be "flying saucers"—but not like any that have been seen on the screen before. Everyone who makes a flying saucer film gets a spun aluminum hub-cap and sails it through the scene by means of little rockets or something like that. The flying saucers will not be the "stars" of our film, but merely elements that exist in this environment. The creation of these saucers is going to be a fantastic thing, because they won't be models or anything made out of metal. They will be forms composed purely of light, shaped like saucers or globes, but able to change shape as well as appear and disappear. Sometimes when they disappear they just shatter into linear energy or suddenly expand and become pure light. I think that working with them will be very interesting.

The slit-scan process is uniquely applicable to certain kinds of requirements. "2001" was probably the ultimate perfect requirement, because what Stanley Kubrick needed in that picture is what slit-scan provides best. It is considered a new photographic technique, but it's not all that new. The basic method has been used in scientific work for some time now. However, it's the present applications that are new, stemming from the work of people like John Whitney.

Slit-scan is applicable to only a certain few special situations, but what it means to the modern film-maker is that he can take something that is essentially dull, flat and static and turn it into something dimensional, with movement and depth and color—something that is visually much more exciting on the screen. ■

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