

SPACE

Apollo Blueprint 1970

Here is your armchair scorecard for Project Apollo, not scheduled for at least five years, but already blueprinted all the way to the moon and back.

By JONATHAN EBERHART

► THE FIRST AMERICANS to reach the moon will land on the lunar surface in a spidery contraption called the lunar excursion module, and return to earth in a tiny cone that flies backwards called Apollo.

Hundreds of thousands of people and billions of dollars are tied up in Apollo, which is not going anywhere at all for at least two years and not to the moon until 1970 (says the National Aeronautics and Space Administration) or 1971 (says everybody else). Nevertheless, a flight plan does exist, complete down to the midcourse corrections for error and the timing of the communications blackouts caused by ionization during reentry. The activities and explorations of the astronauts while on the moon are being worked out step by step, as carefully as the choreography of a ballet.

Here, then, is the flight plan as it stands today. The time is 1971 (or 1970!), and after six weeks of elaborate checkout procedures in which everything but the launch button was put through its paces, the moon-bound Apollo package stands ready to go. Unlike most science-fiction films, the launch will not take place at night under the stark glare of huge spotlights, but early in the morning, when the clear skies will allow the best optical tracking of the early stages of the flight.

Sitting on the launching pad is the seven-layer package that will make the trip possible. Reading up from the bottom, the first layer is the huge S-1C rocket, the biggest, most powerful launch vehicle man has ever built. It will have to produce a thrust of 7.5 million pounds before it even gets off the ground.

Next is the S-II second stage, whose millions of dollars of development and construction costs will all be spent in six and a half minutes of firing.

The last stage of the Saturn V, as the three-stage package is called, has the most complicated job. It is the S-IVB, which will be fired twice, first to put its payload into orbit around the earth, and then to inject it out of orbit and onto its course toward the moon.

After all the rocket stages comes the spacecraft itself, in three segments. On the bottom, inside a protective outer shell, is the lunar excursion module (LEM), which will actually perform the landing on the moon. Above it are the service module (SM) and command module (CM). The CM is the actual "Apollo" of Project Apollo.

Perched on the top of the whole thing is a 14-foot tower festooned with its own rockets and fuel tanks. This is the launch escape system (LES) and will pull the astronauts and their spacecraft clear of the

vicinity if there is trouble with the launch vehicle.

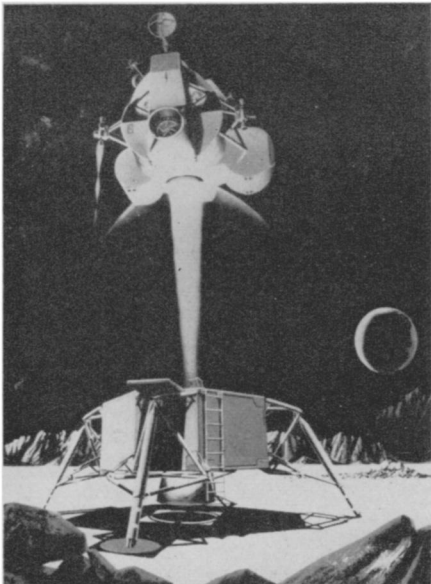
Everything is ready . . . the countdown is proceeding . . . crew checks out fine . . . all systems are green . . . pencil ready? . . . 4 . . . 3 . . . 2 . . . 1 . . . fire!

- The S-1C is ignited, but it seems to hover on its exhaust until . . .
- the hold-down cables are released, and Project Apollo is underway.
- After slightly more than two minutes, a preset guidance computer turns the rocket over on its side, and aims it for its "parking orbit" around the earth. Seconds later . . .
- the S-1C cuts off, the S-II is ignited, and retro-rockets aboard the first stage slow it down and separate the dead weight from the rest of the Saturn V. As S-II fires . . .
- the adapter that joined it with the S-1C is jettisoned, followed by . . .
- the launch escape system, which is no longer needed since everything is going well. The S-II guidance system is now controlling the flight.
- The S-II stage is separated from the package as the S-IVB fires for the first time. The S-IVB computers place the spacecraft in its parking orbit, and then cut off. The astronauts stay in their parking orbit for as many as three trips around the earth, during which time they are figuring out the incredibly exact information needed to set them on the proper course for the moon. They check with ground control at the Integrated Mission Control Center (IMCC) in Houston, and . . .
- fire attitude control jets to tilt Apollo to the proper angle for injection. When the vehicle has come around to the proper point in its orbit,
- the S-IVB is fired a second time. From this point on, the flight is controlled by the astronauts from within the CM.
- The S-IVB engines shut down after a few minutes, and the most spectacular part of the flight so far takes place . . .
- as the adapter covering the LEM opens up like a clam shell.
- The SM and CM, still combined as one unit, then separate from the LEM/S-IVB, turn around 180 degrees in space and . . .
- rejoin the LEM/S-IVB, nose-to-nose. After a brief navigation check,
- the three-part spacecraft (SM/CM/LEM) separates from the S-IVB. This is the shape of things for most of the remainder of the journey, during which time . . .
- three midcourse corrections are made, beginning five to twelve hours after injection, using the engines of the SM. All the data for these corrections are checked, double-checked, and



National Aeronautics and Space Administration

LUNAR CHOREOGRAPHY—Such a map as this might be followed by the first astronauts to set foot on the moon. Laid out step by step like a ballet, the map will help lunar explorers cover the greatest area and investigate the most interesting surface features in the shortest and least-oxygen-consuming path.



National Aeronautics and Space Administration

HOMEWARD BOUND!—*The Lunar Excursion Module (LEM) leaves the moon for home, using its own aft structure as a launching pad. Somewhere above, the rest of the Apollo space package waits in orbit, where the two craft will join forces for the return trip.*

triple-checked with the IMCC back on earth.

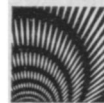
- Moon ahead! Together, the astronauts and the IMCC compute the lunar parking orbit in which the CM will stay while two crew members descend to the surface in the LEM. The pilot orients the spacecraft for insertion into its orbit, and at about 5,200 miles out . . .
- the retro-rockets aboard the SM are fired, slowing the spacecraft down to where it settles into orbit. After the SM/CM/LEM emerges from behind the moon, the co-pilot checks his navigational and landing data with the IMCC, and the third crewman observes the lunar surface, looking for likely landing spots. Likely spots will fall in an area about 1,500 miles long and 200 miles wide, which lies between five degrees north and south of the moon's equator and between plus and minus 45 degrees longitude. After at least one complete orbit around the moon, during which time the orbit is being measured accurately to make sure the LEM will be able to meet it upon returning,
- the pilot and co-pilot crawl from the CM into the LEM, leaving the CM in the hands of the "Third Man," the engineer. After another data check,
- the LEM engines fire briefly to separate it from the CM/SM. The LEM stays near the CM/SM while the descent trajectory is computed, and then . . .
- the LEM slows down and coasts to an altitude of about 50,000 feet, where it . . .

- begins a pass over the selected landing area, as it descends further to about 200 feet. The pilot . . .
- picks his spot, hovers, touches down, and shuts off the engine. The first order of business is then to . . .
- check out the spacecraft, and do everything to be ready for a launch at any time.
- The big moment has arrived! While one astronaut stays aboard, the other climbs down to the surface of the moon. His instructions will cover every step of the way, in order to cover the most area in the fewest time-and-oxygen-consuming steps. "1,000 yards out from vehicle, 500 yards left, install camera A, 150 yards left, etc." are the sorts of instructions he will have to keep in mind. There will be no running and jumping about in the moon's one-sixth-normal gravity. Next to the feat of a successful round-trip, the possible great geological and chemical discoveries appear almost pale.
- After erecting a 10-foot high antenna to serve as a beacon or marker,
- the astronaut will reenter the LEM, and the two crewmen will compute the position of the CM/SM in orbit above them.
- They will launch the LEM into a 50,000-foot-high orbit which will pass slightly behind the orbiting CM/SM. Now comes the pilot's trickiest job:
- He matches speeds with the CM/SM, adjusts the attitude of the LEM, and joins the two spacecraft in space, almost a repeat of the 180-degree turn he performed shortly after injection onto the moon-bound trajectory.
- The crew of the LEM now crawl back into the CM, taking their samples and instruments with them, after which . . .
- the LEM is jettisoned. After checking all the return trip data with the IMCC,
- the pilot will fire the SM engine, putting Project Apollo on its course for home, at about 5,400 miles per hour.
- Just as in the trip out, three mid-course corrections will be made during the return flight. As the CM/SM nears earth,
- the on-board computers and the IMCC will both provide reentry information. The pilot will then reorient the spacecraft, and . . .
- jettison the SM from the CM. Then he will return the CM to its original attitude, in order to be ready for the . . .
- first communications blackout, which is caused by the ionized layer of air surrounding the spacecraft. The layer, produced by the heat of the reentering vehicle, effectively blocks radio communications between the spacecraft and the ground. (However, a water-injection technique, tried for the first time on the manned Gemini 3 shot, may by 1970 have licked this particular problem.)
- The Apollo capsule, all that is now

(Continued on p. 383)

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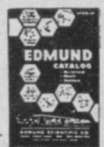
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Apollo Blueprint 1970

(Continued from p. 379)

left of the original seven-part package, gets as close to the earth as 200,000 feet, before it swings outward again to prevent overheating in the atmosphere. This brief dip into the air has slowed the craft down, however, and . . .

- a second reentry begins at 300,000 feet, with another radio blackout. Now things start to happen thick and fast.
- At 50,000 feet the capsule's forward heat-shield is jettisoned.
- At 25,000 feet a drogue chute is opened to straighten out the vehicle so that the other chutes will work properly.
- At 15,000 feet a pilot chute will be fired automatically and will drag the main chute system out behind it. The main system consists of three 88-foot ring-sail parachutes, which lower the CM with its three astronauts to earth at about 24 feet per second.
- **SPLASH!**

No matter what the astronauts find when they get to the moon, no matter how many scientists have predicted it in advance, Project Apollo will be one of the most remarkable feats in the history of man. About the only thing that could add excitement to the flight would be the discovery of little green men.

• Science News Letter, 87:378 June 12, 1965

PHYSIOLOGY

Rough Surface Running Develops Ligaments Best

► **RUNNING** on a rough and uneven surface may be the best way for football players to strengthen their knee ligaments.

Research with white rats indicates that this may be true, reports Dr. Adran Detar Adams, graduate student at the University of Southern California in Los Angeles and assistant professor of physical education at San Fernando Valley State College, Northridge, Calif.

In a gymnasium for rats, Dr. Adams found that the group of animals exercised in a rotating drum with an uneven surface developed the strongest knee ligaments.

Football players and other athletes often tear ligaments which must be repaired by operations on the knee.

"It may be desirable for these athletes to anticipate the stress of quick changes in direction and the stress of heavy body contact by preparing the ligaments of the more vulnerable joints with preliminary stretching," Dr. Adams said.

Familiar exercises like the deep knee squat or squat jumps may even be dangerous, he pointed out. These exercises often cause insecure footing or loss of balance, which may tear the ligaments rather than strengthen them.

"It may be advantageous to exercise the knee joint systematically by running on rough or uneven surfaces or by performing exercises that serve to stretch the ligaments rather than immobilize them," Dr. Adams said.

• Science News Letter, 87:383 June 12, 1965

Make Money Writing Short Paragraphs

Chicago Man Reveals a Short Cut to Authorship

Discloses little-known angle by which beginners often get paid five to ten times more per word than the rates paid to famous authors. Now anyone who can write a sentence in plain English can write for money without spending weary years "learning to write."



FOR years and years a relatively small number of people have had a "corner" on one of the most profitable authors' markets ever known. They've been going quietly along selling thousands and thousands of contributions. None of them have had to be trained authors. None of them have been "big name" writers. Yet, in hundreds of cases they have been paid from five to ten times as much per word as was earned by famous authors.

The successful men and women in this field had such a good thing that they kept it pretty well to themselves. Mr. Benson Barrett was one of these people. For years he enjoyed a steady income—made enough money in spare time to pay for a fine farm on the outskirts of Chicago.

Finally, Mr. Barrett decided to let others in on the secret. Since then he has shown a number of other men and women how to write for money. He has not had to give them any lessons in writing. He has not asked them to go through any long course of study or practice. In fact, most of his protégés have started mailing contributions to magazines within two weeks after starting with his plan.

Mr. Barrett says that the only skill required is that the aspiring author be able to write a sentence in plain English. Almost anyone with a common school education can write well enough to follow Mr. Barrett's plan, because the contributions you will send to magazines are rarely more than one paragraph in length.

Shut-ins, housewives, folks who are retired on small incomes, even employed men and women who like to use idle hours in a constructive way—all types are making money on short paragraphs.

Mr. Barrett does not teach you to write. He shows you *what* to write, what *form* to put it in, and *who* to send it to. He shows you a simple method for *getting ideas* by the hundreds. He gives you a list of more than 200 magazines that are looking for this kind of material and will buy from beginners. In other words, he teaches you a method, an angle, a plan for starting to write right away for money.

IF you would like to see your writing in print and get paid for it—just send your name on a postcard to Mr. Barrett. He will send full information about his plan of coaching by return mail—postage prepaid. He makes no charge for this information. And, no salesman will call on you. You decide, at home, whether you'd like to try his plan. If the idea of writing twenty or thirty short paragraphs a week and getting back a lot of small checks appeals to you, ask Mr. Barrett for this information.

No telling where it might lead. Such a small start might even open opportunities for real authorship. And, since it can't cost you anything more than a postcard, you'll certainly want to get all the facts. Address postcard to Mr. Benson Barrett, 6216 N. Clark St., Dept. 163-F, Chicago 26, Illinois.