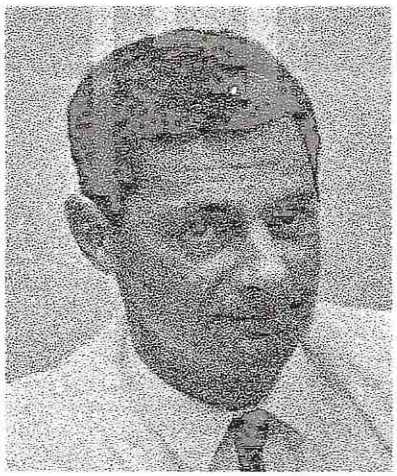
Bee Hive:
Quarterly Publication
of United Technologies

As a major Project Apollo contractor, United Aircraft took a pivotal part in the lunar landing mission last summer. It helped put man on the moon, keep him alive there, and return him to earth. Thousands of United Aircrafters contributed to the efforts, some of which stretch back to the 1950s, in research, design, development, manufacture, and test that went into the equipment the corporation created for Project Apollo. Three men at United Aircraft had special responsibilities in Apollo 11. They are the program managers for three sets of equipment that were instrumental to the success of the mission.

3 ON

By Frank G



1

JACK LEE: Chief of the Powerline

John Maxim Lee took his first airplane ride at the age of four or five, back in the early '30s, as a passenger on a test flight of a Fairchild Pilgrim. The pilot wore a parachute. No one else aboard did; not young Lee, his sister, his mother, or his father.

"My father was project engineer at the time for Fairchild on the Pilgrim, and the plane had a rattle or a noise or something, and they wanted to take it up to see what was wrong," Lee recalls. "It was a Saturday, so he took the family along. The test pilot was Dan Beard, who later became a vice president of American Airlines."

Young Lee doesn't recall that he was beset by nervousness at all when he went up without a parachute in the Fairchild Pilgrim, a single-engine, fabric-skinned monoplane. But understandably he admits to a feeling of anxiety during Apollo missions.

Lee is program manager for Pratt & Whitney Aircraft's Powercel® units, or fuel cells, which generate all electricity aboard the command and service modules throughout the Apollo flights. The Apollo 11 mission, in which Neil Armstrong and Edwin Aldrin landed on the moon, lasted 195 hours from liftoff to splashdown. Pratt & Whitney Aircraft's Powercels aboard were actually in operation for a total of 255 hours, beginning five days before launch. They continued on line until 25 minutes before splashdown when the service module, containing the fuel cells, was jettisoned from the command module carrying the astronauts to a landing.

Three fuel cells are aboard for each Apollo mission. They produce electricity through a controlled electrochemical reaction between hydrogen and oxygen, both stored aboard in liquid form but supplied to the cells in a gaseous state. A by-product of the chemical reaction is pure water, which Armstrong and Aldrin drank and used to reconstitute their food and do certain cooling jobs. The powerplants are each capable of supplying up to 2,200 watts of electricity.

"They fill all the electrical needs of the spacecraft: not only the everyday requirements we on earth might have at home, like cooking, heating, and cooling," Lee said, "but also for such equipment as TV cameras, communications, telemetry, and the guidance computer. These functions and others all depend on the fuel cells for their electrical power."

During the Apollo 11 mission, data on the Powercels' performance was gathered by Pratt & Whitney Aircraft engineers at NASA's Manned Spacecraft Center in Houston and transmitted by facsimile apparatus for analysis 'round the clock by engineers at the company's South Windsor Engineering Facility in Connecticut. Lee himself was on duty there about 12 hours a day. He slept when the astronauts did, while their spacecraft was powered down and the load on the fuel cells was light.

"We kept an especially close check on performance while Armstrong and Aldrin were on the moon," he said. "Because Collins was alone in lunar orbit in the command module, he was too busy to monitor all his systems in full detail. So we watched the fuel cell performance extra carefully."

Lee feels the pressure during a mission. "The equipment is out there, a quarter of a million miles away: three powerplants operating on the same gas supply and feeding into the same power system," he said. "They must work, and they must work perfectly. You can't reach out to touch them. You can't fix them if anything goes wrong. They just have to work."

And work they have. Since the first Powercel flew in space in 1966, 24 of the units have accumulated more than 3,000 hours of operating time in eight Apollo flights, three unmanned and five manned. Although

APOLLO

there are three fuel cells aboard, two can fill the power requirements for a complete mission, and one is sufficient to provide all the power needed to return the astronauts safely to earth.

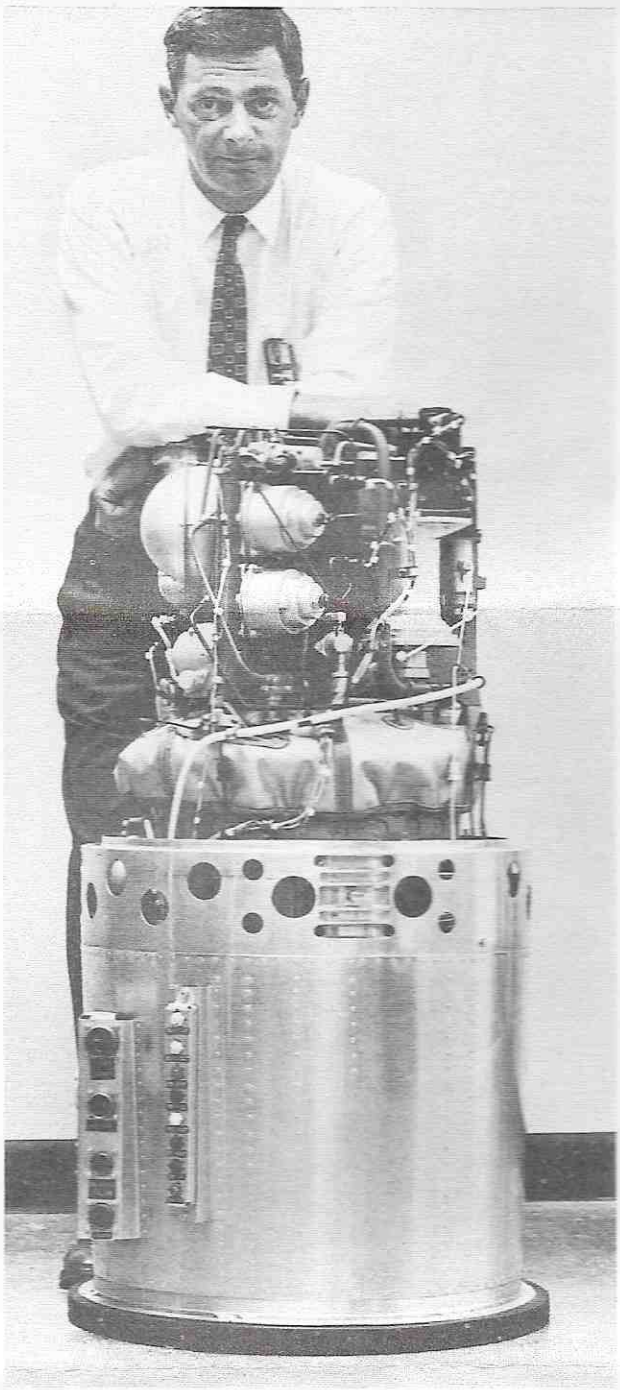
"You're always aware during a mission," Lee said, "that if anything is going to go wrong, it will be the unexpected. The anticipated you've already taken care of, on the basis of past experience."

The Apollo cells are flight-qualified for 400 hours of operation, or more than twice the duration of the maiden lunar landing mission. There were no fuel cell problems during Apollo 11, and when the mission was over, Lee felt relief and pride at the achievement of "the huge team of which we're a small part."

But the pressure is never really off him, even at splashdown. While one mission is in progress, he and his fuel cell team are getting ready for the next one. When Apollo 11 splashed down, the three fuel cells for Apollo 12 were in their spacecraft at Cape Kennedy being prepared for vacuum testing, in which the entire spacecraft and its systems, with the astronauts aboard, go through procedures in a space simulation chamber.

Lee, a slim, dark-haired man of 42 who sails in his 35-foot sloop and does woodworking for relaxation, has been managing the company's Apollo fuel cell program since 1967. He is quick to stress that, while he happened to be manager at the time of the moon landing, the real credit for the cells' successful development and performance goes to hundreds of people, many of them now working elsewhere in the company, who have contributed to the project over the years. At its peak, early in 1964, he pointed out, more than 1,000 persons at Pratt & Whitney Aircraft were directly involved in the program. Lee has taken part since 1962 when Pratt & Whitney Aircraft was selected as fuel cell subcontractor to North American Rockwell Corporation, the Apollo prime contractor. What he marvels at most about the lunar landing program is how the efforts of thousands of persons of diverse skills and disciplines, spread all across the country, are marshalled, organized, and coordinated to achieve an objective of such magnitude.

For Jack Lee, pursuit of an engineering career was, as he puts it, "all but inescapable" because of his family background. His father, John G. Lee, a prominent figure in aeronautical circles, was with United Aircraft for more than 30 years and, at his retirement in 1964, was director of research for the corporation. On his mother's side, too, Jack Lee comes by a strong technical heritage. His maternal great-grandfather was Sir Hiram Stevens Maxim, who developed the first successful automatic machine gun and experimented with a steam-powered flying machine in England in the 1890s. Sir Hiram's son, Hiram Percy Maxim, invented the Maxim silencer for handguns.



Lee is shown with a Powercel® of the type that generates on-board electricity during Project Apollo missions.

Like his father and maternal grandfather before him, Jack Lee went to Massachusetts Institute of Technology, earning his degree in chemical engineering and economics in 1951. On graduation, already married and the father of two, he took a job with Du Pont. He went with another company after six years at Du Pont, and finally joined Pratt & Whitney Aircraft in 1959, going directly into fuel cell projects, then in their infancy at the company.

From then on, Lee's efforts were directed at the day when the company would lay a powerline to the moon and back.