The Terminal Landing System (TLS) and
Landing Operations Test Vehicle (LOTV)
by Larry Schmitt

Imagine for a moment that you are seated in the wide-open side of a helicopter, facing outward to the world, flying along at an altitude of 10,000 feet. There you are, hanging out in the breeze, depending on your seat belt and shoulder harness for security.
It's a cool, nearly clear day with some scattered, puffy clouds at 12,000 feet - just above.

You can almost see forever. The rolling hills of the Texas landscape vanishing into the haze at the horizon where the blue sky overhead meets the limestone caliche and mesquite trees on the ground. It is a hot summer day in Great State of Texas, but cool and comfortable at your altitude. The breeze feels good. You're flying like an eagle. The world is yours.

Over your headset you hear radio communication from the TLS operator to the helicopter pilot. It's time for you to prepare the LOTV, within your reach - attached on the side of the helicopter, for another parachute drop test. You quickly complete your check-list and notify the pilot that everything is ready. Soon afterward, you feel the helicopter decelerate slowly to a near-hover, then roll slightly to the left in response to release of the 400-lb. LOTV.

At that point things get exciting as the helicopter quickly spirals down into a steep banking turn, in order for the crew and perhaps an onboard photographer to watch a strangely-formed parachute deploy from the LOTV and to follow it down to a touchdown far below. You wonder how you got so lucky. You actually get paid a good salary for this.

Flying might not be all plain sailing,
but the fun of it is worth the price.
Amelia Earhart

The Terminal Landing System (TLS)
A spacecraft land landing was a early goal of the Gemini Program. The concept was envisioned to include a steerable wing-like Paraglider with inflatable booms, landing skids, rocket thrusters to soften the touchdown, plus real time guidance control to ensure safe landings. The complexity of this unproven system proved to be impractical for the Program timeline, so an ocean landing with existing parachute technology was chosen instead.

In addition to the low lift-to-drag ratio (L/D) Paraglider, Francis and Gertrude Rogallo of the NACA (and later NASA) at Langley, had also experimented with gliding Parasail parachutes that did not employ inflatable booms. This type of more conventional parachutes were to be considered for later phases of the Program to satisfy the land landing goal. LRD was tasked

with determining the operational equipment requirements and the associated landing techniques, as well as conducting proof of concept testing as part of the systems development process.

The TLS along with the LOTV were specifically designed for the test project. Figure 1 shows the TLS compound set up at Fort Hood Army Base, in the Great State of Texas. A remote area was selected and prepared by Base engineering for LRD test equipment, consisting of an S-Band radar van, a mini-mission control/computer van and a LOTV command and control van. After months of equipment checkout at Ellington Air Force Base, along with helicopter drops of the LOTV/Parasails at 3,000 feet, the three vans and supporting hardware and chase vehicles were taken to Fort Hood.

On a hypothetical spacecraft reentry and landing day, the TLS radar would first track weather balloons to establish a wind speed/altitude profile, next track the spacecraft during reentry and deployment of the gliding parachute, then track and compute flight path guidance control to landing. The target landing zone for the reentering spacecraft was assumed to be several miles in diameter. Using the reentry tracking data the TLS could predict the parachute deployment point in advance. With the deployment point and the wind profile established, TLS operators would calculate the zero lift landing point and a flight profile for an onboard astronaut to steer the spacecraft within the capability of the gliding parachute and land into the wind at the best touchdown point.

With well over 300 gliding parachute drop tests from 10,000 feet at Fort Hood, the LRD successfully developed all of the equipment requirements along with the operational TLS techniques that were necessary for land landing. The field test project equipment and the associated operations were demonstrated to NASA management on several occasions with live LOTV drop tests. LRD operators of the TLS van from Dale Moore's section included Don Bourque, Bill Middleton, J. T. Chapman, Don Harris and others. Operators of the Radar van from Bill Chase's section included Don Morris, John Haughton, Jack Sloan, Al Meyers and Charlie Hall.

The Landing Operations Test Vehicle (LOTV)

Figure 2 shows the LOTV hanging at the side of a Bell UH-1D "Huey" Army helicopter from utility attachment arms widely used by the Army (at the time, for Vietnam-era Gatling guns). Our particular attachment configuration employed a standard military (bomb rack) release mechanism so the LOTV could be dropped with the push of a button on the pilot's cyclic control stick.

The LOTV was shaped much like a small Mercury/Gemini spacecraft, made of high strength, heat-treated steel to protect the internal batteries, parachute line control motors, radar

beacon, command receiver & telemetry transmitter electronics, as well as a downward-looking TV camera. It's a wonder that it weighed only about 400-lbs.

A console inside the LOTV command and control van had a TV monitor and hand controller for the simulated onboard pilot to have an out-the-window view of the ground, while remotely controlling the gliding parachute above the LOTV. Flying the LOTV from a ground position would be similar to the toy drones you can now get at Wal-Mart, but it was rather unique for the 60's. After LOTV test operations began in the field, Ray Petrowski, Larry Petty, Larry Majors, Jerry Fleming, Harold Seigfreid and others that worked in the Technical Services Division tagged it the “Little Ol’ Test Vehicle,” and that name stuck. LRD test conductors and operators of the LOTV van from Royce McKinney's section included Fred Koons, Larry Schmitt, Albert Ong, Phil Charlton, Lamar Flanagan, Ron Epps, John Hamlin, Ed Jackowsky, and Wayne Gotsch.

Figure 3 shows the helicopter and Snowball-2 (discussed below) in position for recovering the LOTV and parachute in the field. It could be refurbished and flown again about 4-6 times a day, almost as fast as technicians “Pappy” Virden, Gordon Miller or Billy Drummond could repack the parachutes.

According to the Technical Services personnel who worked with the LOTV, it had an uncanny attraction for cow patties. There were not many stray cows on Fort Hood, but if there was scat of any variety around, the LOTV landed in it. Some thought this was due to TLS pilot technique while others said it was an intentional LRD design feature, but that was never really settled.

Figure 4 shows Fred Koons making the final preparations at altitude before dropping the LOTV over Fort Hood, Texas, and Figure 5 shows the LOTV in flight with a single-keel Parasail and helicopter in the background. The drop altitude depended on cloud cover and the particular test plan of the day, but was usually as high as 10,000 feet. This provided a very realistic test for a hypothetical spacecraft returning to Earth with a gliding parachute recovery system.

The gliding parachutes tested with the LOTV had a L/D ratio between 0.25 and 0.5 - with a descent rate of around 30 feet per second the forward velocity was typically about 10 feet per second. This provided the hypothetical on-board astronaut with enough control so that he could maneuver over a large site, visually see the exact landing spot, and head into the wind for a controlled touch-down. Several types of gliding parachutes used with the LOTV included the single-keel Parasail, the multi-keel Sailwing, and a Cloverleaf design. Figure 5 shows the LOTV with a Sailwing (this design had a high L/D, but large-scale versions of that design were difficult to deploy, as I recall). Figure 6 shows the LOTV with a Parasail and the UH-1D

helicopter in the background. This Parasail gliding parachute design was the most practical at that time, in my opinion.
Figure 7 shows the LOTV about to land on Antelope Mound, Fort Hood.

Snowball-1
Snowball-1 was a white (thus named "Snowball") Dodge pickup truck fitted with UHF and VHF aircraft-type radio communications equipment for flight test support in the field and with equipment used to check parachute rigging on the ground before the chutes were air dropped. Figure 8 shows Snowball-1 and Snowball-2 on a taxiway at Ellington AFB, evaluating and trimming a Parasail to be used with the LOTV.

Snowball-2
This was an early model Jeep with a white top, outfitted with radio and hoisting equipment designed for down field chase and recovery of the LOTV. Using the hoist, the LOTV could be easily attached to the side of the helicopter.

Another story - of an experience I had one warm, Sunday evening in October:
I was driving my nearly-new MGB to Fort Hood for a new week of LOTV operations. There I was humming along in my sports car with the top down on Texas Highway 36, enjoying a winding two-lane country road at that time. There was little traffic, the MGB was running well (I may have been driving a little faster than the speed limit), but just after rounding a curve at speed I heard a horn honk. It was one of the Tech Services technicians passing me in Snowball-2!! With all that radio gear and the hoist hanging out, whistling in the breeze, he waived as he went by. I have always suspected that Ken Easley or one of the other hot-rod guys in the Technical Services Division had “tuned” the engine of Snowball-2.

The Cowhouse Motel and the Blue Moon Cafe
No discussion of the TLS, the LOTV and the operations at Fort Hood, Texas, would be complete without mentioning the Cowhouse Motel and the Blue Moon Cafe. That’s where much of the daily planning for LOTV and TLS operations were done. At that time, the Cowhouse was the best (and maybe the only) place to stay in Killeen, Texas, and the Blue Moon Cafe, a decent place to eat, thanks to a couple of friendly waitresses. For some unknown reason, the Blue Moon always served a sliced beet with every meal, but the chicken fried steak or enchilada plates were good and the coffee excellent.

LRD Spaceflight Meteorology Group
Each morning of our planned drop tests, the test conductor would make a call back to Houston and get the latest forecast from the Meteorology guys in the MCC. If Roger Carter was on duty, he would ask the test conductor, "What does it look like there now?" The test conductor would give him a best-guess of cloud type, altitude and wind direction. Invariably,

Roger would reply, "Well, it'll just be more of the same." With that, Roger would end the call and leave the test conductor just shaking his head.

FIGURES:

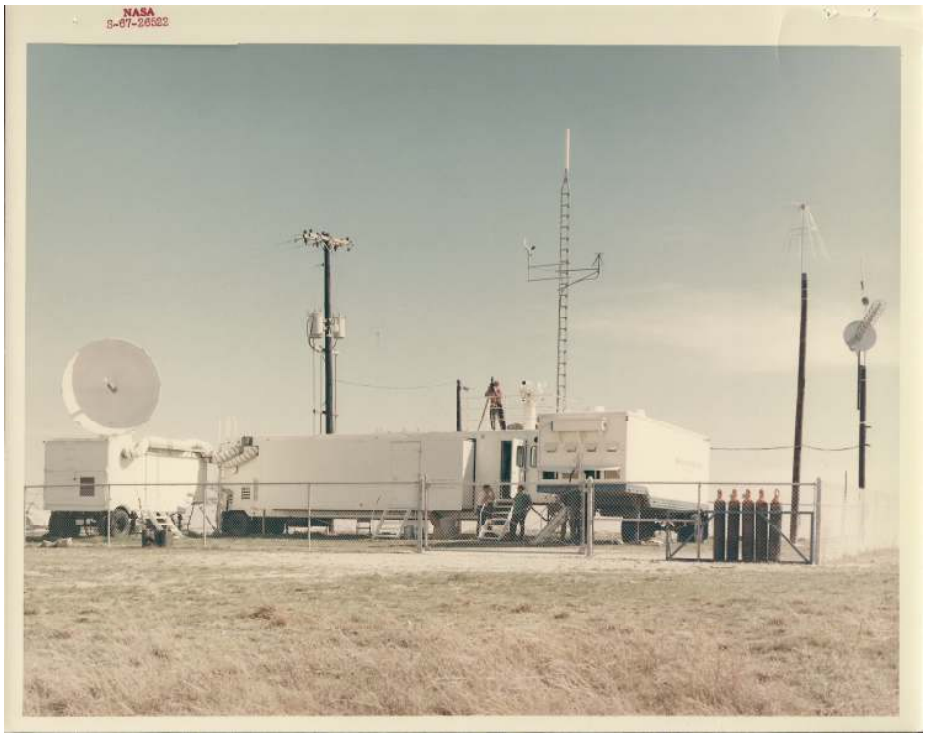

Figure 1: TLS Compound (Photo Credit: NASA S-67-26522)

Figure 2: LOTV and UH-1 Helicopter (Photo Credit: NASA S-67-18553)

Figure 3: Helicopter and Snowball-2 (Photo Credit: NASA S-67-26544)

Figure 4: LOTV Just Before Drop (Photo Credit: NASA S-66-49808)

Figure 5: Sailwing (Photo Credit: NASA S-68-31268)

Figure 6: LOTV and Sailwing (Photo Credit: NASA S-67-26540)

Figure 7: LOTV Landing (Photo Credit: NASA S-67-26553)

Figure 8: Snowball-1 and Snowball-2 (Photo Credit: NASA S-68-31616)