Good & Bad News from Space

OrbView-3 Launched; Landsat-7 Crippled

On 26th June, the long awaited launch of the OrbView-3 satellite with its high-resolution imager took place successfully from Vandenberg Air Force Base in California. Just three and a half weeks before this event, on 31st May, the operations of the very successful Landsat-7 satellite with its medium-resolution ETM+ imager were suspended. This was due to a fault that has developed in the scanner imager. Potentially this could bring the L-7 mission to an abrupt end, four years after its launch in April 1999.

By Prof. Gordon Petrie

OrbView-3 Launch

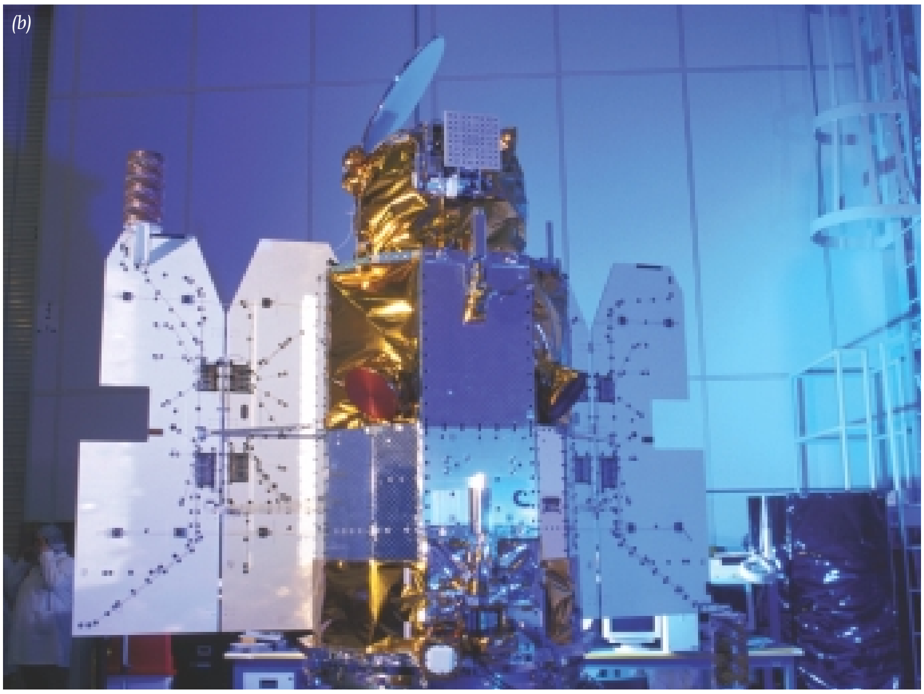
The OrbView-3 satellite was launched using the Pegasus air-launched rocket developed by the Orbital Sciences Corporation, which also built the satellite. This three-stage solid fuelled rocket was designed specifically to launch small satellites of up to 1,000 pounds (450kg) in weight into a low Earth orbit (LEO). In fact, the launch of OrbView-3 was the 34th flight of a Pegasus rocket, the first of which was flown in 1990. The rocket and the attached OrbView-3 satellite was mounted underneath a specially modified Lockheed L-1011 TriStar aircraft (called "Stargazer"). The aircraft then carried the Pegasus rocket and the satellite to an altitude of 40,000 ft. (12,192m) over the Pacific Ocean. Once the aircraft had reached the desired position, the rocket with its attached satellite was released and allowed to free-fall in a horizontal position for five seconds before starting its first-stage rocket motor. The launch went off successfully, placing OrbView-3 into its initial parking orbit. Over the next few weeks, the satellite will be manoeuvred into its final circular Sun-synchronous orbit having an orbital inclination of 97.29 and an orbital altitude of 470km. Besides these orbital manoeuvres, the satellite and its imager will need to be checked out fully before it can be declared to be operational.

ORBIMAGE

For the rather beleaguered Orbital Imaging Corporation (ORBIMAGE), the news of the successful launch of OrbView-3 was most welcome. As discussed in past issues of GeoInformatics, after the failed launch of the larger OrbView-4 satellite in September 2001, the ORBIMAGE company had placed itself under Chapter 11 of the U.S. Bankruptcy Code. This allowed it to be re-organized and to be restructured and reinforced financially so that the company could continue its operations. However the continuing delays experienced in finally completing the OrbView-3 satellite resulted in several postponements of the launch date during the latter part of last year (2002) and the first part of this year (2003). This caused further difficulties for the company. So the successful launch comes as a relief and gives it a real boost towards ensuring the continuity of its business.

OrbView-3 Imagery

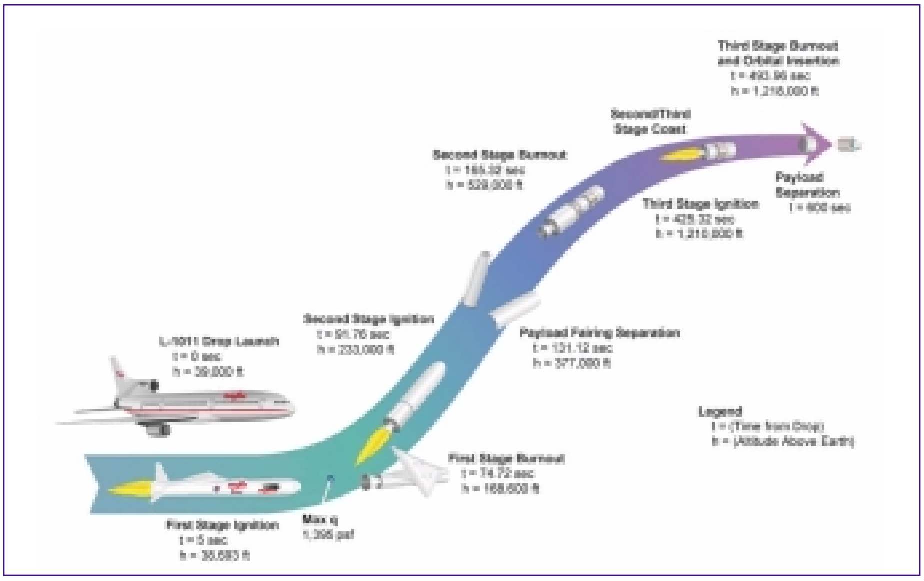
Once the satellite comes into full operational service, OrbView-3 will generate high-resolution panchromatic (black-and-



(a) The OrbView-3 satellite being checked out in a clean room at the Orbital Sciences Corporation's facility in Virginia.
(b) The OrbView-3 satellite with its solar panels extended. (Source: Orbital Sciences Corporation)

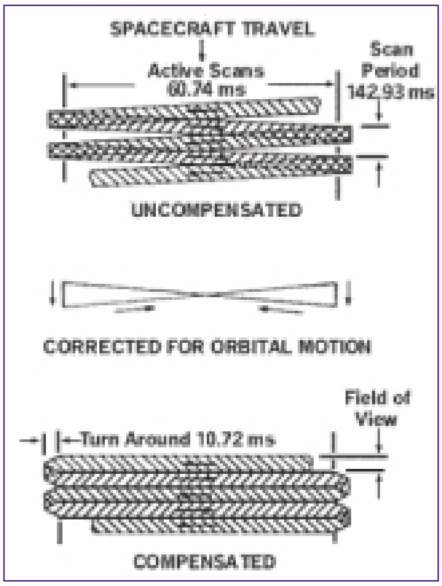
The air-launched Pegasus rocket with its tiny delta wing. The front part of the rocket houses the OrbView-3 satellite, which is covered by a protective fairing.

The Lockheed L-1011 "Stargazer" aircraft from which the Pegasus rocket was air-launched. The rocket with its satellite can be seen mounted underneath the aircraft. (Source: Orbital Sciences Corporation)



The mission profile for the launch of the Pegasus rocket, showing the three stages of the rocket propulsion; the ejection of the protective fairing; and the insertion of the satellite into its initial parking orbit. (Source: Orbital Sciences Corporation)

white) imagery having a ground pixel size of 1m, together with multi-spectral imagery having a ground pixel size of 4m. In many respects therefore, the OrbView-3 image data will be similar to that produced by Space Imaging's IKONOS satellite. However it will have a narrower swath width of 8km as compared with the 11km wide coverage generated by the imager on IKONOS. Like IKONOS, the OrbView-3 satellite can point its imager sideways from its orbital track at angles up to 45 from the vertical. The image data can be stored on-board the satellite and can then be downloaded to



This diagram shows the action of the scan line corrector (SLC) in correcting the images being captured by the ETM+ scanner for the forward motion of the Landsat-7 satellite. The top diagram shows the overlaps and gaps occurring between adjacent lines when the SLC is not functioning. The bottom diagram shows the results when the SLC is working properly. (Source: USGS)

ORBIMAGE's master ground stations located at Dulles, Virginia and at Point Barrow in Alaska. The data can also be downloaded locally in real time for reception at the ground stations operated by ORBIMAGE's partners - e.g. the station built by the Canadian MDA company that is owned and operated by NTT Data in Japan.

Landsat-7 Malfunction

As noted above, the ETM+ scanner instrument on board Landsat-7 started to malfunction on the evening of 31st May through the failure of the instrument's scan line corrector (SLC). This is an electro-mechanical device that controls the movements of small corrector mirrors to compensate for the forward motion of the satellite during the scanning of each individual line of the image. In this respect, an oscillating plane main mirror is used in the ETM+ instrument to perform the scan of the ground at right angles to the flight direction. Since the bi-directional movement of this main scanning mirror takes a little time to carry out the scan of a complete line, during this time, the satellite is continuing its forward movement over the Earth. So the SLC mechanism with its small motor-driven corrector mirrors is inserted between the instrument's main optics and its detectors to correct for this forward motion of the satellite. With the SLC having ceased to function, this causes adjacent scan lines to overlap partially and to leave discernible gaps between parts of the adjacent lines. These overlaps and gaps occur towards the edges of the ETM+ images; whereas, at the centres of the image lines around the nadir, the adjacent line images will still give near-contiguous coverage of the terrain surface.

L-7 Image Data & Alternatives

At the time of writing, a team of engineers is investigating the cause of the SLC's malfunction and is trying to establish whether remedial action can be taken to eliminate or overcome this malfunction. Investigations are also under way to see whether the overlaps in the data lines can be eliminated and the gaps filled in using suitable interpolative techniques. In the meantime, the production of L-7 ETM+ data has stopped. Users are being informed that useful data alternatives exist in the form of Landsat-5 TM data; the images being acquired by the Advanced Land Imager on NASA's EO-1 satellite; and those being captured by the various ASTER imagers on board NASA's TERRA satellite. In this particular context, one notes that the winners of the competition for the Landsat Data Continuity Mission (LDCM) are due to be announced quite soon. However, even then, a period of two years will elapse before the replacement satellites can be constructed, launched and brought into service.

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