NASA TECH BRIEF

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Time Data Sequential Processor (TDSP)

The problem:

A program was needed to study near-Earth conic trajectories and to provide approximate preflight predictions for tracking stations.

The solution:

The Time Data Sequential Processor (TDSP) computer program was developed to provide preflight predictions for lunar trajectories from injection to impact, and for planetary escape trajectories for up to 100 hours from launch.

How it's done:

When the hardware configuration of the launch vehicle is such that engine burn duration is from launch to injection, then the case is referred to as direct ascent. No attempt is made to simulate the powered flight portion of a direct ascent case; TDSP commences from the injection epoch.

An alternate launch method boosts the vehicle into an Earth parking orbit and, after a short coast time, initiates a second burn which injects the vehicle on a predetermined flight path. When this is the case, TDSP simulates the parking orbit and second burn phases in addition to the free fall phase. No attempt is made to simulate the powered flight portion from launch to parking orbit injection; TDSP commences from the parking orbit injection epoch.

When the target is the Moon, an encounter phase of the flight is initiated as the probe enters the Moon's gravitational field. The lunar encounter portion of the trajectory is approximated by a rectilinear hyperbola as determined by conditions near the Moon's sphere of influence.

Three modes of input are available for data input to the program. The first of these is a magnetic tape, written by the conic programs SPARC for planetary targets or STACT when the target is the Moon. The second mode of input is punched cards containing a set or sets of injection conditions for each launch azimuth, time data, and other required data. The third mode of input is a polynomial input option where the program accepts a set or sets of injection conditions and time data in the form of polynomials.

Given the injection conditions, TDSP can generate a chronologically ordered set of events, consisting of (a) solutions of the classical two-body problem, to obtain position and velocity as a function of time, and (b) variables which are functions of position and velocity. A variety of output formats corresponding to the specific option requested are available. It is also possible to save, on magnetic tape, the time-sequential history of the spacecraft ephemeris, events which have occurred, related tracking station data from up to a maximum of 10 stations, and additional TDSP computed quantities which are of interest in mission planning and predicting. This magnetic save tape is then used for data plotting. The tape is requested by input option and is written in the binary mode in a fixed format. Provision has been made to control the volume of data by varying the step size and then writing a record every nth step.

TDSP uses the JPL ephemeris system tapes to determine lunar position and velocity when these quantities are required. Reading the ephemeris tape results in extracting Cartesian coordinates of the Moon referenced to the mean equator and equinox of 1950. These coordinates are then rotated to the mean equator and equinox of date.

TDSP provides two input means for externally controlling the volume of printed output: variable trajectory termination time, and print only at requested time points. The former is convenient when, for example, tracking ships are requested and data are only desired for a short period of time.

(continued overleaf)

Tracking stations of the Deep Space Instrumentation Facility (DSIF) may be simulated using a topocentric spherical coordinate system, the positions of the 10 DSIF stations being defined by nominal values in TDSP. Certain quantities computed relative to the stations are oriented toward the hardware configuration of the DSIF stations.

One of the major options TDSP performs is the determination of tracking station view periods. The times of spacecraft rise, extreme elevation, and set with respect to the stations, and the orientation of the spacecraft relative to the station at these times, are computed and printed. Included in the view period capability is the ability to predict the entering and exiting of the Earth's shadow by the probe. View periods for a maximum of 10 stations are available. Another major option is the capability to generate geocentric and station fine prints.

Notes:

1. This program is written in FORTRAN IV and MAP for use on the IBM-7094 computer.
2. Inquiries concerning this innovation should be directed to:

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Patent status:

No patent action is contemplated by NASA.

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