D EARTH RESOURCES LABORATORY APPLICATIONS SOFTWARE (ELAS)

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In 1978, it was decided that USC should actively pursue obtaining the hardware/software necessary to do image processing and the classification of Landsat data. At that time, USC computer services was heavily committed to the maintenance and development of its graphics capabilities and it was felt that the landcover data available through Landsat would be a useful compliment to other data (soils, census data, political boundaries, roadways, climate), that was being collected. Some state agencies had contracts, notably with Stanford and ERL, to do specific projects along these lines and it was felt that USC could better meet the needs of the state locally.

A Data General Eclipse Model S/230 mini-computer originally purchased for another purpose was now dedicated to graphics. After suitable modifications, i.e., the additions of a large disk drive, dual density tape drive and an image processing display device, the minimum hardware necessary to do image processing and classification of Landsat data was in place.

Simultaneously, the task of obtaining a suitable software package to do the calculations necessary to this type of work was undertaken. Several systems were originally considered until it was decided that The Earth Resources Laboratory (ERL) software would best fit the needs of USC. Under their technology transfer program, ERL supplied a copy of the software then being used at Slidell, Louisiana as well as the promise of help in setting it up.

Since no new contracts involving the use of these capabilities were pending, it was felt that USC could afford to spend the time setting up the system and tailoring it to fit individual needs. Hardware considerations demanded a FORTRAN based mini-computer system. Shop policy demanded source listings and documentation. Cost involved the manhours and travel necessary to learn and implement the system. The source software was supplied free of charge under the technology transfer program.

Implementation of the system proceeded satisfactorily. In October, 1979, it was semi-operation (i.e., a scene could be reformed, searched, classified and grouped). At this time, in a routine visit to Bay Street -

Mississippi, ELAS was introduced. After judging its merits versus those of the earlier system, it was decided to implement ELAS. A major factor in this was the disclosure that ERL would no longer support the old system once ELAS was totally operational. There was a little difficulty implementing a couple of key modules (namely programs to overlay 2 different scenes and the program to geographically reference a classified scene). It was felt that USC could get ELAS up and implement the overlay and georeference overlays in only a little more time than it would have taken to implement the old modules. (Hindsight shows this judgement correct).

In March, 1980, the image display device arrived and shortly thereafter, USC produced a general landcover map of South Carolina using a hybrid system. The Landsat scenes that made up the map were reformatted, searched and classified under the old modular system but were georeferenced, displayed and grouped into landcover types using ELAS. The individual scenes were then merged into the state data base grid on the universities' mainframe. A tape was subsequently prepared from which the map was produced.

ELAS is now fully operational at USC. The latest project involving the classification of Greenville County in South Carolina was done from Landsat tapes to overlay to final landcover classification on a UTM coordinate grid, entirely by ELAS.

Throughout the implementation procedure, ERL willingly answered questions and supplied, if available, updated programs and documentation when asked. However, the entire task of implementing ELAS was essentially done by USC. This was done partly out of preference, but mostly out of necessity since the Data General Eclipse used by USC is not directly compatible with the Interdata upon which ELAS was developed at ERL.

Hardware differences include the use of 16 bit word versus a 32 Bit word. The smaller addressability results in less space being available for program overlays. This necessitated cutting down some array sizes as used at ERL. The DG Eclipse does not support INTEGER*4 arithmetic which is used extensively throughout the ELAS package. This was rectified by changing all INTERGER*4 variables to REAL and watching for places where floating point arithmetic cannot be used. To date, the resultant loss of significance has not proved to be a problem.

These problems, however, were minor compared to the main task of interfacing the ELAS software to Data General's FORTRAN callable runtime routines. Hence USC had to write its own versions for many of the

subroutines. Notable among them were the subroutines that handle input/output and those that bring in the various overlays.

Every machine handles I/O in its own way. Thus, the packages handling tape I/O, disk I/O, terminal I/O and Comtal I/O had to be developed locally. This is a major but unavoidable undertaking when implementing software on any machine not exactly identical to the machine on which the software was developed. ELAS does however use general I/O subroutines which contain most of the machine dependent calls making this task a little easier. These were totally re-written locally and all the programs linked so that those routines are always resident.

Once the resident section of code was complete, implementation of the individual overlays proceeded fairly easily. However, each overlay did need to be debugged and tested to check for things such as array size and INTEGER*4 arithmetic. The overlay structure of ELAS is such that this can be done without any undo effects on the other overlays. Also, each overlay is linked separately so that the entire ELAS package does not have to be re-linked every time a new overlay is introduced.

There is, however, one time when every overlay does need to be re-linked. That is when a change is made in any of the routines that are always resident. Then every overlay has to be re-linked and re-checked for unforeseen effects. This however, is more prevalent early on when the problems that occur are likely to be those of the resident routines and structure. Once these stabilize, the implementation of any individual overlay is relatively straight forward. At this time, users can write and implement their own overlays without any undue problems.

In general, ELAS is an extremely flexible and workable system for processing Landsat type data. This very flexibility, however, is both its strength and its weakness. In order to make full use of ELAS, the people using it need to have a thorough understanding of it and what they are trying to do. This precluses outside users from working with the system by themselves. Normally, one of our staff works in conjunction with an outside user to produce the product desired.

User documentation is extensive, relatively reliable for such a new system, but takes an understanding of the system in order to use effectively. ELAS is available through NASA's Technology Transfer Program and the version to fit a Data General Computer is available from USC.

ELAS is a good and flexible tool and recommended for any user who can invest time and money for full utilization.