DIGITAL MAPPING AT THE AUSTRALIAN KEY CENTRE FOR LAND INFORMATION STUDIES.

by E. Walker

Queensland Centre for Surveying and Mapping Studies
Box 2434 G.P.O.
Brisbane 4001
Australia.

ABSTRACT

The paper describes the establishment of and development plan for the Australian Key Centre for Land Information Studies, located at the Queensland Centre for Surveying and Mapping Studies, Brisbane. The Key Centre pursues education, training, and industrial development in the fields of Land Information Systems, Digital Mapping, and Remote Sensing, and has an opportunity to investigate and develop interfaces between these areas. Details are given of the already significant facilities available at the Centre, together with planned facilities and details of a number of case studies completed and in progress, primarily in the digital mapping area.

INTRODUCTION

The Australian Key Centre for Land Information Studies was established in 1985 by a grant from the Australian Government in response to applications from leading academic institutions throughout Australia. This followed the formation of the Queensland Centre for Surveying and Mapping Studies which was created in the same year by an academic and scientific amalgamation of the surveying departments of the University of Queensland (U.Q), the Queensland Institute of Technology (Q.I.T.), and Darling Downs Institute of Advanced Education (D.D.I.A.E.). This amalgamation has created the largest and best equipped school of surveying and mapping education in the country and has enabled the centre to achieve "critical mass" with respect to research and development activity. The Key Centre is supported by the Research and Development Section of the Queensland State Government's Department of Mapping and Surveying, and by the University Departments of Geography, Regional and Town Planning, and Computer Science, and the associated departments at Queensland Institute of Technology and Brisbane College of Advanced Education.

Aim and Objectives.

The aim of the centre is to provide a Key educational facility specialising in Land and Geographic Information Systems, with their associated input, processing and output systems, covering Australia and the Asian Pacific region.

The aim will be achieved by the offering of formal and continuing education courses, from para professional to doctoral levels; training; industrial research and development; and consultancy.

The Key Centre is multi-disciplinary, and attracts students, educators, and researchers from such areas as computer science, geography, regional and town planning, and government and law, as well as surveying and mapping.

Facilities.

The Key Centre has access to equipment on the two major campuses and at the State department of Mapping and Surveying. A planned build-up of specialist equipment dedicated to the Centre's objectives is in progress and will continue over the next two years. In addition equipment manufacturers are cooperating in making equipment available over short and long terms for special purposes such as short courses.

1. Major laboratories :-

Function.	Location.
Land information systems	U.Q./Q.I.T.
Remote sensing	U.Q./D.M.S.
Photogrammetry	Q.I.T./D.M.S.
Cartography	Q.I.T.

Both campuses have extensive computing facilities, including PDP, VAX, and IBM mainframe computers. Networking is available through the linking of various systems on and between the major campuses.

2. Major equipment :-

Land Information Systems :-
Input:
Monochrome terminal workstations 3
Colour terminal workstations 2
Digitiser, AO 1
Tapedrive 1
(Shared facilities of Computervision, Australia)
Processing:
CDS 4000 Computervision computer 1
(32 bit, 600 Mb hard disk)

Output (Cartographic):

G.D.S. drafting system on VAX 780 computer	.....	1
PALLETTE drafting system on VAX 780	.....	1
Graphics terminals	.....	8
Flat-bed plotter	.....	1
(All above shared facilities of QIT campus)		
Plotter/Digitiser (in PLANICOMP environment	.....	1
Flat-bed plotter	.....	1
(Shared facility of Computervision, Australia)		
Line-printers	.....	2

Remote Sensing :-
Digital image processing systems :-

1. Micro-Brian, implemented on IBM AT computer (currently one system, 3 more to be acquired)
2. U. of Q. system developed in-house by Dr. G. Dowideit, based on Ramtek/PDP 1144, plus SLIP
3. SLIP/Comtal/Vax system at State Dept. of Mapping and Surveying.

Optical image processing systems :-

1. I2S multi-projector system
2. Binoccular 4-chip viewer.

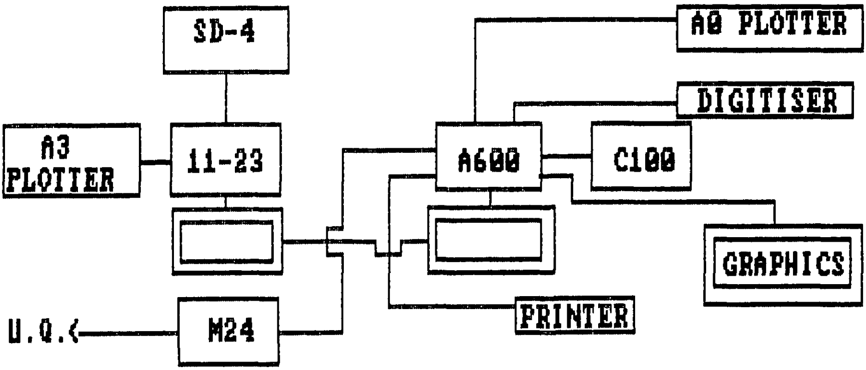
Photogrammetric :-
Analytical stereo-plotters :-

Zeiss Planicomp, with AO plotter	.....	1
QASCO SD4, with A3 plotter	.....	1
Analogue stere-plotters, numerical o'put	.....	4
Analogue stereo-plotters, graph output	.....	6
Orthophoto instrument, Zeiss O-3-P	.....	1
Metric terrestrial cameras	.....	4

Access to following instruments through the Queensland Department of Surveying and Mapping :-
APC IV analytical stereoplotter
Zeiss Orthocomp analytical orthophoto instrument
Computer supported analogue plotters
Related computer software :-
PATMR - robust aerial triangulation by models
PROSA - progressive sampling of terrain models
HIFI-PC - terrain modelling by finite elements, with profiling and contouring capacity
PLANIMAP, -digital mapping system on PLANICOMP

DIGITAL MAPPING SYSTEM

The elements of the digital mapping system of the Key Centre, located at the Q.I.T. Campus, are illustrated in Figures 1 and 2. The core of the system is a Zeiss Planicomp C130 analytical photogrammetric plotter, supported by a QASCO SD4 analytical photogrammetric plotter, and three digitally encoded analogue photogrammetric plotters.



QIT DIGITAL MAPPING SYSTEM
Figure 1.

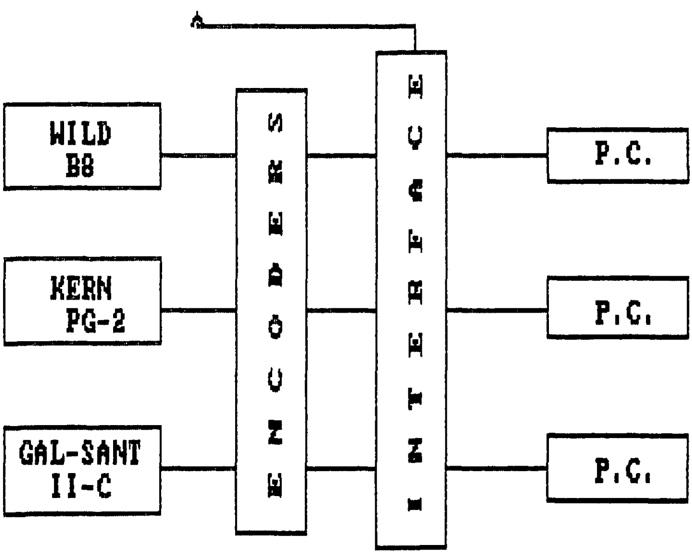


Figure 2

The Zeiss Planicomp

The Zeiss C130 planicomp is controlled by a Hewlett-Packard 1000 Model A600 mini-computer. The operations of the Planicomp are performed by some 80+ programs, organised in three levels A,B,C, programs from a higher level (A,B) being able to run concurrently with one from the lower level. Thus it is possible for instance to change model or plotting parameters, inspect or modify control information or direct output to the screen or plotter and return immediately to pending photogrammetric operations on the instrument. It is also possible to carry on program development or normal computer management operations on the H.P. 1000 while running the Planicomp. Input peripherals include a H.P. drum plotter/digitiser, an additional Aristogrid digitiser, and an input link from the QASCO SD4 analytical photogrammetric plotter. Output is to H.P. hard disk or cassette, to 20 cm floppy disk via the link to the PDP 11-23, or to 13 cm floppy via the link to the Olivetti M24. Data can be tranferred off-line via 20 cm floppy to the Q.I.T. central DEC10 or VAX780. A selection of some planicomp facilities is listed at Table 1, and the standard mapping programs sequence at Figure 3.

PLANICOMP FACILITIES

INPUTS	PROCESSES	OUTPUTS
C-P PHOTOGRAPHS	AFF. FILM CORR'N	POINT RECORD
DIAPS/NEGS	RADIAL DIST'N	TIME INC. REC.
COLOUR/PAN	REFRACTION	DIST/HT INC. REC.
FILM/GLASS	EARTH CURV.	PRIM. & SEC. INCS.
FORMAT<240 MM	AFF. MAP CORR'N	VAR. OUTPUT FORMS.
240 MM PORTIONS	INST. CAL. DATA	VAR. OUTPUT MEDIA
	ORTHO/PSEUDO VIEW	LINE, CIRCLE,
	BIN. L/R VIEWING	CURVE, SYMBOL,
	INDEPENDENT/INTEG.	TEXT, GRID,
	PHOTO MOVEMENT	PARALLELS, SQUARE/
	ORIENTATION WITH	POLYGON COMPL'N,
	NUMERICAL ANALYSIS	TO SCREEN OR PLOT.
	TRACING, PROFILING,	
	POINT AND SPLINE	
	MEASUREMENT	
	BRIDGING AND A.T.	
	ADJUSTMENT	
	AUTO POINT	
	POSITIONING	
	EXTENSIVE DATA	
	HANDLING FACILITIES	

Table 1

PLANICOMP PROGRAMS SEQUENCE

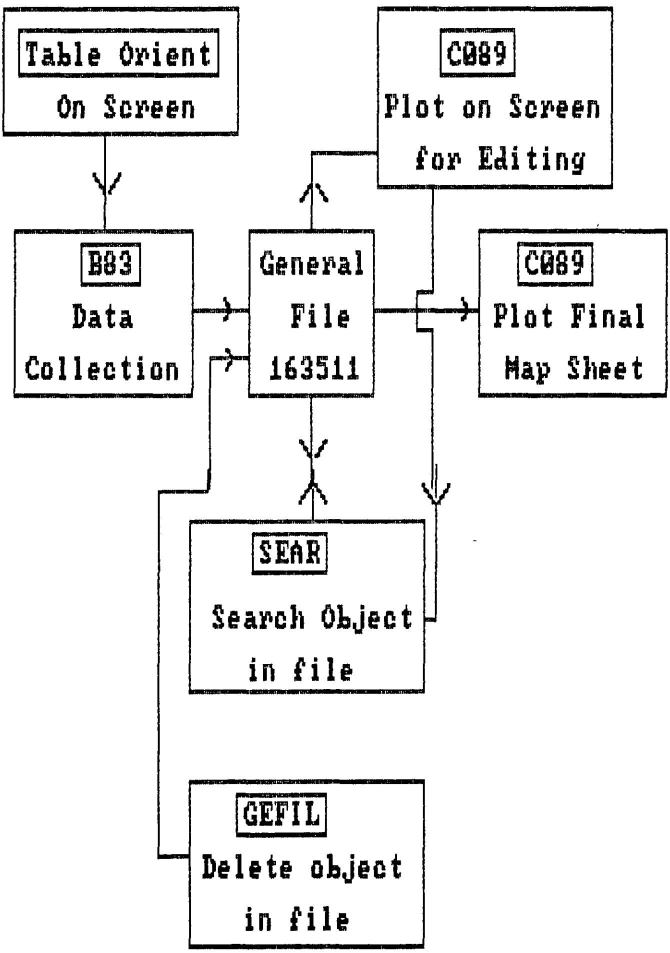


Figure 3

The QASCO SD4 Analytical Stereoplotter

The SD4 is a low-cost medium accuracy analytical plotter designed and built in Australia by the Queensland Air Survey Company. The instrument has been in use in the Surveying department of Q.I.T. for four years, and has now been integrated into the digital mapping system of the Key Centre. As can be seen from Figure 1, the plotter is controlled by a PDP 11-23 computer which incorporates a 20 cm floppy disk drive and a 20 Mb hard disk subdivided into eight user areas plus a system area. Photogrammetric movement is by two joy-sticks, although the conventional handwheels and foot-disk can be supplied. The basic accuracy of the instrument is dictated by the fact that photo-stage movement is by stepping motors with a 6 micrometer step, giving a measuring accuracy of about 10 micrometers. All operations are controlled on the basis of a 'job-file' in which photographic and photogrammetric parameters are entered for a particular model or series of models- this file is then called on by the system to control for instance the range of photo-stage movement for automatic positioning during relative orientation, or control point identification during absolute orientation. Model coordinates throughout are at 'ground scale', initially estimated from the job-file parameters and finally established by absolute orientation.

Digitisation density in the the SD4 is determined by the dimensions of a 'rejection cube' selected by the operator - dimensions in Easting, Northing and Height are specified, defining a parallelepiped with origin at the coordinates of the last record - another measurement will not be recorded until the floating mark moves outside the 'cube'. Alternative patterns of grid or profile with specified alignment are available in optional software packages.

The SD4 has been found to be extremely valuable in the teaching of analytical photogrammetry, being easy to use in a short time - necessary for intensive practical exercises - with easy-to-follow on-screen menu operation and useful printouts of results. It has been used for classwork in all photogrammetric operations, including analogue and analytical aerial triangulation, contouring for orthophoto production, and detail plotting in both aerial and terrestrial mode. In addition it has been used in more advanced project work and consultancy, primarily exploiting its capacity in using terrestrial photography in various formats.

Analogue stereoplotters

The development of the three analogue plotters into an integrated unit as shown in Figure 2 is planned over the next two years. All the instruments are fitted with encoders but currently only the Wild B8 is interfaced with a micro-computer (Apple II+) and controlled by an operating system (SPADD). It is proposed to re-write the operating system in Fortran and use modern 16-bit micro-computers as controllers.

DETAILS OF DIGITAL MAPPING PROJECTS

1. Micro-terrain mapping

In order to support a research project of the School of Australian Environmental Studies at Griffith University, Brisbane, mapping was required of soil terrains in a rainfall-simulation flume. The research was aimed at modelling rainfall erosion parameters for various soils and rainfall types, and mapping with 5 mm contours was required after each 'event', the terrain being planar before the simulated rainfall. Photography was with ordinary high-quality 35 mm cameras from a photographic distance of 1.5 m. The digital mapping was performed on the Planicomp, camera parameters being determined by the "bundle orientation" technique. In this technique a normal relative and absolute orientation is performed to give initial parameters for the bundle orientation. In addition, best estimates are entered for the camera parameters focal length, principal point coordinates, and distortion curve. The program then performs an iterative bundle orientation with additional parameters, finally creating a new spatial model based on the results. Digitisation was by contours with output on the drum plotter. For future analysis of the results it can be noted that the Planicomp inludes the programs HIFI with which interpolation onto a regular grid can be made, and also PROSA - progressive sampling - with which interpolation can be optimised into areas of greatest variation. The use of these should enable comparison of the various digital outputs from the mapping. The project is ongoing.

2. Preliminary Evaluation Program for SPOT(PEPS)

Dr. E. Clerici, Head of Department of Surveying, Q.I.T. is the Principal Investigator in a PEPS project with the following reference - "An investigation of SPOT stereoscopic imagery for application to Digital Terrain Models (D.T.M.) and the production of orthophotos and conventional line maps at medium to large scales in Australia". The measurement of the DTM will be carried out on the C130 Planicomp, and the orthophotos will be produced from conventional photography on the Z2 Orthocomp. A necessary preliminary to the project is the development of a new LOOP (analytical plotter feed-back) program for the Planicomp enabling the measurement of coordinates from 'pushbroom' imagery as opposed to the conventional central projection geometry of photography. This has been completed by a post-graduate student and at the time of writing the supply of imagery is awaited. Under the terms of this project further details cannot be reported until any data or results have first been reported to the PEPS Secretariat.

3. Beach Protection Mapping

Historical mapping over some 25 km of beach on the Gold Coast, Queensland was performed to assist in the detection and monitoring of beach movement over the period 1930 to 1979. Selected photography of 1930, '35, '44, '56, '62 and '79 was mapped digitally on the Planicomp C130, 35 models over 7 sites being mapped. The flexibility of the analytical plotter was exploited in the use of a wide range of input imagery, photography from Williamson-Ross (7"x5"), Eagle IV, Eagle IX, RC8, RC10, and F24 (5"x5") cameras being used. Although specific calibration data on the older cameras was not available, distortion curves characteristic of the lenses were used with satisfactory results. Control was based on ground survey lines run for the 1979 photography, and passed back through time by transfer using common detail, which was always available. Thus all data was relative to the 1979 control.

Three modes of data acquisition were employed :-

1. A digital elevation model at 10 m interval.
2. Profiles along the ground survey lines, and at +/- 100 m along the beach from them.
3. 1 m contours and detail.

The ability of the Planicomp to "move to" points of given coordinates, and to profile in given directions was of great value. Graphical output was limited to the detail and contour plots, the whole of the digital data being transferred to the Beach Protection Authority's VAX, filling 12 DSDD Olivetti floppies along the way.

Digital Mapping of an Ocean Going Sailing Hull
(Smith 1985)

In the run-up to the America's Cup, ocean sailing is a hot topic in Australia. An interested sixth-stage student decided to jump on the bandwaggon by doing his final thesis-project on a related theme. Hull profiles and water-line length are important inputs (among many others in this complicated process) in determining the rating of an ocean racing yacht. In the past these measurements have been obtained by tedious operations with plumbobs, strings, and tapes; more modern techniques, including the use of lasers, have been suggested for introduction in 1987. The method used in this project was that of terrestrial photogrammetry using a metric camera and the C130 Planicomp. Due to time and logistic constraints, one side only of the yacht, a 12 m standard class sloop, was photographed and mapped, the hull being covered by two overlaps at a photographic distance of 9.5 m from the yacht centre-line with a 100 mm focal length lens. Digital data was acquired in the form of contours in the vertical plane. A great advantage of the analytical photogrammetric approach in this case is that, once the data has been acquired, output in any plane can be plotted, such as contours in elevation, or cross or longitudinal sections. The contours were digitised in 'spline' mode on the Planicomp, which is advantageous for data density - in this mode, point-wise recording along the contour is performed and the program constantly computes a spline fit and stores the data in the form of the spline parameters. A disadvantage of the mode, as opposed to direct tracing, is that care must be taken to increase the recording density where there are abrupt direction changes, and in extreme cases to digitise also break-lines and process the data through the HIFI program.

An interesting logistic aspect of this project was the necessity to give the hull of the yacht 'photogrammetric texture'. This was achieved by painting a random 'squiggle' pattern across the whole hull, alledgedly with an easy-to-remove water paint. However, when the time came to remove the pattern it was found that the paint was not so easy to remove as advertised, and many man-hours were spent restoring the hull to its pristine white.

CONCLUSION

An outline has been given of the establishment and objectives of the Australian Key Centre for Land Information Studies, located at the Queensland Centre for Surveying and Mapping Studies, Brisbane, Australia. The Key Centre is one of seven Centres established in various disciplines by the Australian Government in 1985 with the view that the concentration of teaching and research effort flowing from such centres would be an important factor in assisting higher education institutions respond to emerging national needs and forge closer links with industry. The Key Centre at Brisbane is well placed with respect to equipment and expertise to achieve such objectives in the areas of Land and Geographic Information Systems, Remote Sensing, and Digital Mapping.

Reference:

Smith, S., 1985, Terrestrial Photogrammetry Applied to Ocean Going Sailing Racing Hulls, Thesis-Project Report,Brisbane, Queensland Institute of Technology.