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PRODUCTION EXPERIENCE WITH THE HUNTING DIGITAL MAPPING SYSTEM

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1. Introduction

The international contract mapping market is highly competitive in cost, delivery and performance. In 1972, Hunting Surveys started to assess digital mapping techniques as a method of reducing map production costs, speeding up deliveries, and extending the range and versatility of survey data products, without sacrificing quality. It seemed unlikely at that time that it would soon be possible to purchase a system which would satisfy our particular requirements and five years later it seems just as unlikely. A number of digital systems were already in operation or under development which showed that computer-assisted mapping was feasible but, as there was little evidence that such systems were sufficiently versatile and cost-effective to justify private investment, the company realised that it would have to design its own.

The original design by K.M. Keir was subjected to a feasibility study by computer consultants, SPL International Limited, and the potential performance and cost-effectiveness was assessed internally. Both reports were favourable and the development was approved. This original design has served us well. It has proved sound in principle and sufficiently flexible to accommodate modifications in detail.

The primary purpose of the system is to produce graphical maps to the unlimited variety of specifications demanded by our clients all over the world. We are not in the position of government and defence agencies and research organisations of being able to dictate the storage medium and the style of presentation of survey data. Most map users are conservative; they want their maps to match the style of the ones they had last year which are very little different to those of twenty years ago. The system has been designed with high quality cartographic presentation to almost any style as the primary objective as this is where the demand lies. The ability to produce digital ground models, databases, calculations of areas and volumes, digital or graphical profiles and cross-sections is an essential but, for the moment, secondary advantage. We needed a new computer to process aerial triangulation, geodetic networks, volumetric computations and for a variety of other functions, and it was logical to design a system with spare background processing capacity for these purposes.

An on-line system was chosen with a single mini-computer interfaced to a number of stereo-plotters and a flatbed plotter as being the most cost-effective method available to us for capturing, processing and presenting map data to a high cartographic standard. Individual on-line units based on analogue or analytical plotters would have been prohibitively expensive, and would probably have lacked the capacity required for cartographic refinement and the adjustment of large blocks of aerial triangulation. An off-line system would have involved separate magnetic tape registration units for each stereoplotter as well as additional processing of superfluous data and seemed to us unlikely to offer either a substantial reduction in man-hours or acceptable cartographic quality.

We were in an easier position than the instrument manufacturers in that we were not designing a system to please anyone other than ourselves, although that is difficult enough. We also had the benefit of advice and criticism from people who were going to use the system in production. This ensured that the production staff remained fully in control of the system, had demanding and worthwhile jobs to do and did not become mere appendages of automated machines.

We were not concerned in proving that maps can be produced without human intervention and have used automated techniques only where they are likely to be more efficient than conventional ones.

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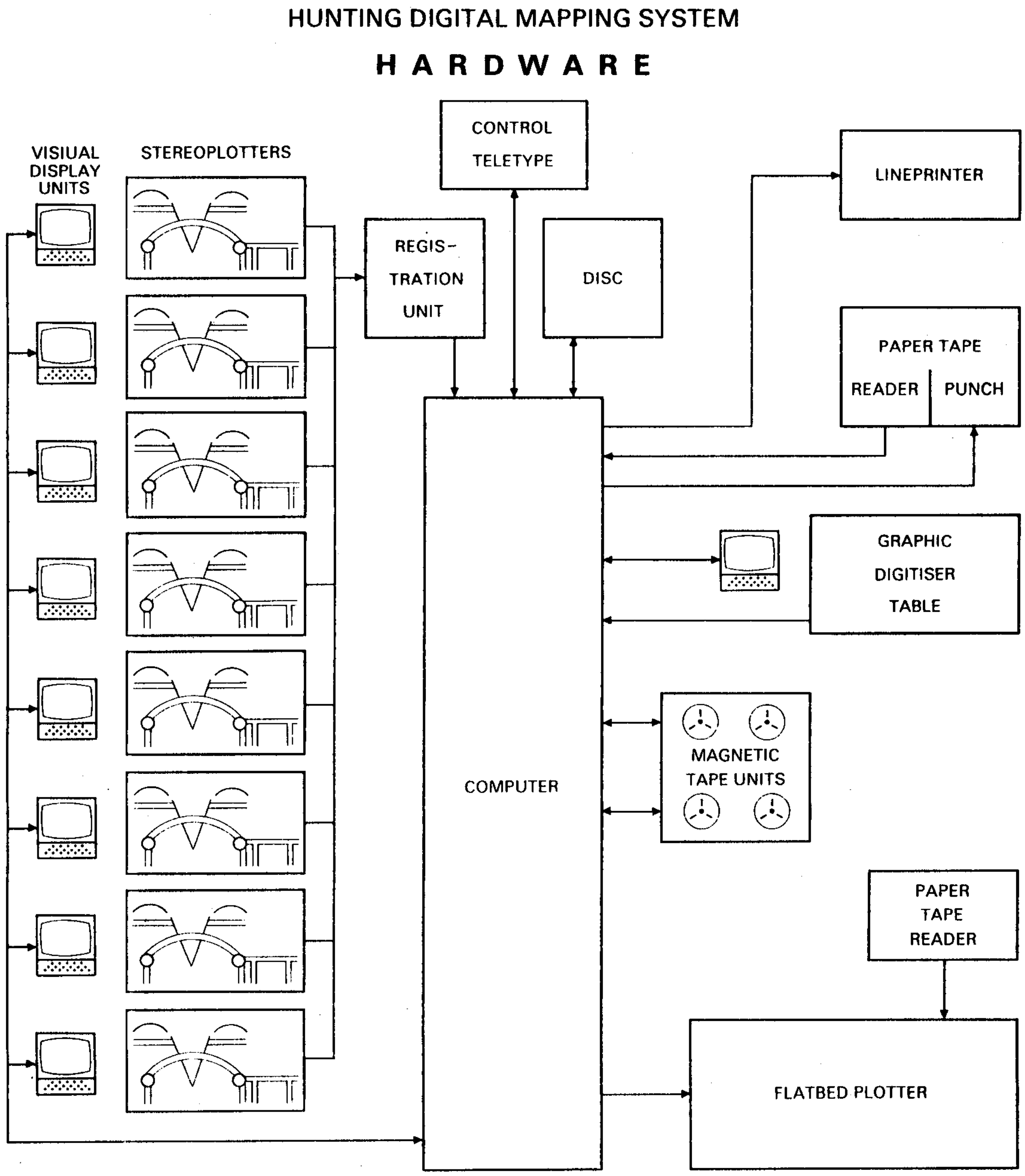

Figure 1

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2. System configuration

The hardware and software configuration of the Digital Mapping System has already been described in some detail by its designer, (K.M. Keir - ISP Helsinki 1976) and only a brief outline will be given here.

The hardware consists of a central computer on-line to eight stereo-plotters, one XY-digitiser, one flatbed plotter and nine visual display units (Figure 1).

The computer is a DEC PDP 11/50 with 96K of 16-bit memory, a large disc drive of 20 million works, two 9-channel magnetic tape units, paper tape reader and punch, lineprinter and teletype.

The stereoplotters are Wild A8s fitted with incremental encoders, linear in X and Y and rotary in Z, and warning devices to detect loss of datum. Each instrument is equipped with an alphanumeric visual display unit with keyboard and either a mirror profiloscope or a closed circuit television attached to the plotting table. Each stereoplotter can be used individually for conventional or digital mapping.

A Ferranti Freescan XY-digitiser table, with an identical visual display unit, is also on-line, and is used both for editing and updating data collected at the stereoplotters, and also for digitising existing maps and drawings from other sources.

Visual display units provide communication between the operators and the computer. The operators obtain computer-assistance with various routines including absolute orientation and the selection of feature codes and can enter information at the keyboard. The computer displays the current operational status, model coordinates and routine instructions and the computer operator can pass special instructions to individual instrument operators.

The flatbed plotter is a Ferranti EP 331, which is mainly driven on-line but can also plot simple data off-line from punched tape input. The plotter is installed in an air conditioned darkroom, and is equipped with a light-spot projector for exposing on photographic film as well as the usual plotting heads with holders for pens and scribing tools. The Laserscan HDI plotter at Cambridge can also plot data from the system, which provides useful additional capacity during overloads.

The real time disc operating system and system control program were designed by SPL, our computer consultants, to extract maximum use from limited resources by giving priority to the foreground operations such as capturing data and driving the plotter, and the remaining capacity is allocated to data processing in background. The system can capture from all eight stereoplotters and the digitiser, drive the flatbed plotter and perform some background processing simultaneously. Each of these activities can relate to eleven entirely different projects.

During on-line operation 20K of central processor memory and half the disc space can be made available for unrelated background processing. This is used to adjust geodetic networks and blocks of aerial triangulation, to calculate camera calibrations, areas and volumes, and process data for digital output. Programs which require more memory can be run when the system is not on-line, by using the DEC operating system. The computer can be left running unattended at night, and at weekends, to plot heavy sheets on the flatbed and to process large quantities of data such as thousand model blocks of aerial triangulation.

Model coordinates in each stereoplotter are measured with a resolution of 10 µm and are recorded in stream mode at a rate of up to 50 points per second. Superfluous data is filtered immediately and only significant points, needed to define the precise shape of each feature, are stored on disc: this reduces the volume of stored data and the subsequent processing by about 90 per cent.

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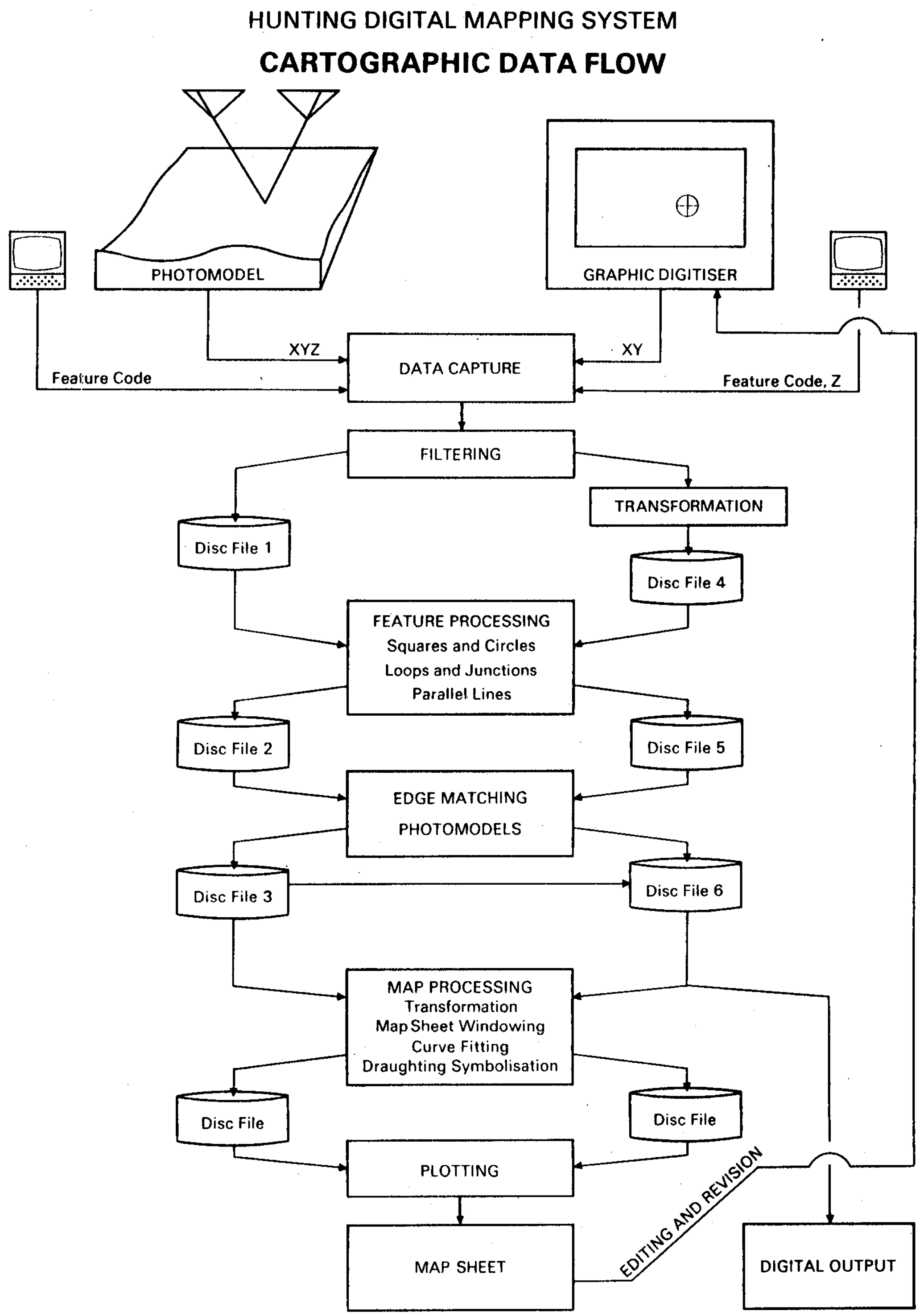


Figure 2

Features can be digitised by tracking, by flagging critical points to be retained during filtering, by generating straight lines between points, or by recording discrete points. The feature currently being digitised can be deleted partially or completely.

Each type of feature is identified by a code of up to 4 digits entered at the keyboard. The code is selected from a feature database, which is displayed as a menu on the screen, and is steadily being extended and rearranged to accommodate every cartographic feature which we encounter around the world.

Data captured from the stereoplotters and the digitiser table is filtered and stored on disc in photomodel files for processing in background. For security these files are backed up on magnetic tape every few hours.

Background processing is performed in stages and can be started as soon as whole photomodels have been captured (Figure 2).

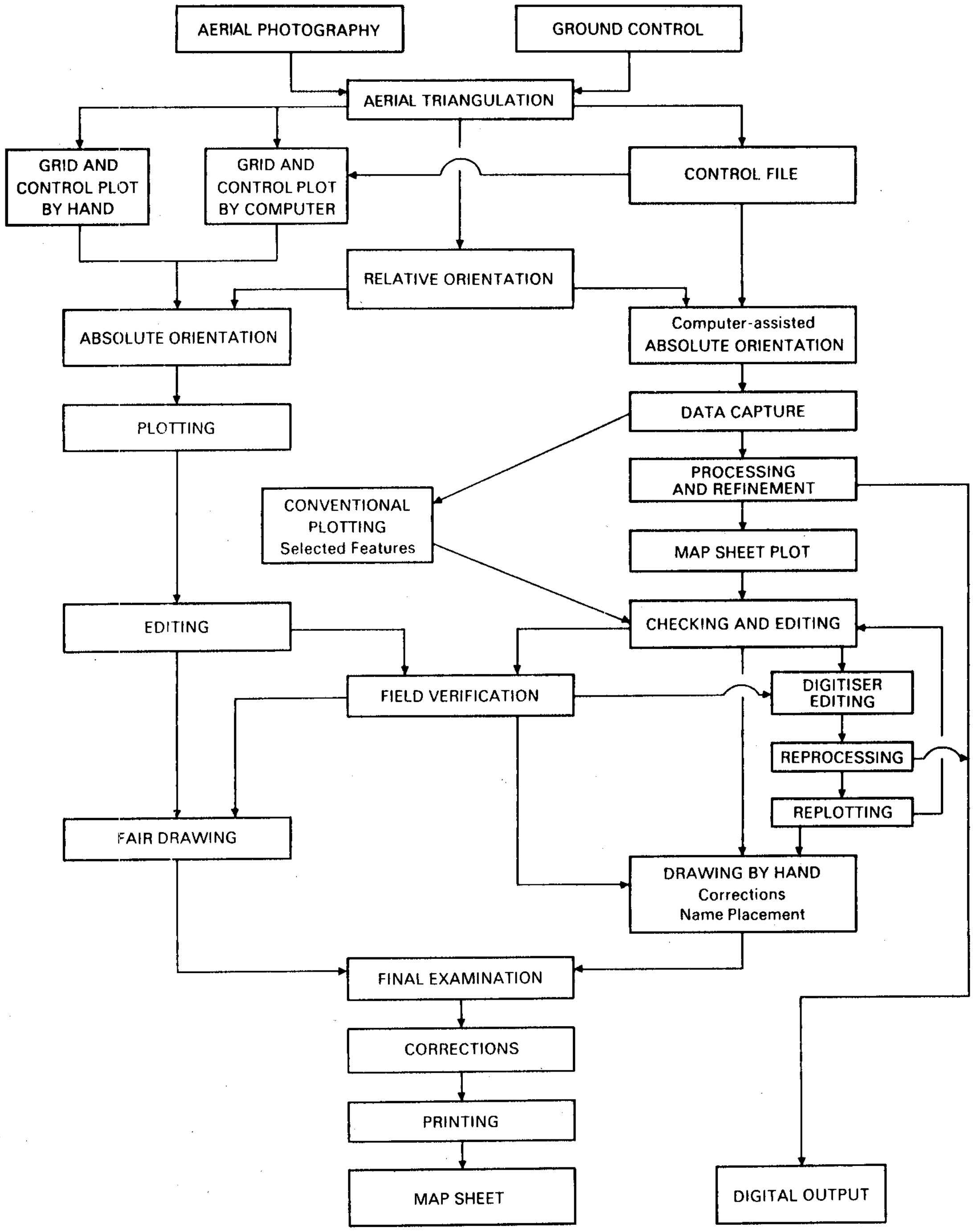
Various enhancement routines are applied to particular categories of features to close loops and junctions, to impose rectangularity or circularity, and to generate parallel lines. All sinuous line features are subjected to a curve fitting routine to produce smooth natural curves. The method of filtering and curve fitting developed by Keir is described in his paper (Keir 1976).

Adjacent photomodels are edge-matched and the data is windowed to the chosen map sheet format and transformed direct from model coordinates to plotter table coordinates at map scale. The drawing specification for each project is defined by selecting the line weights, styles, point symbols and annotations for each type of feature. Plots can be produced at any scale either in groups of photomodels or formatted to any rectangular sheet size up to 1.5 x 1.2 m.

Additions and deletions can be made to the digital data at the Freescan digitiser to edit, correct, and incorporate field verification, revision and any other information, after which the data is reprocessed and replotted. The digital data can also be output as a digital database, which involves reformatting to meet individual client's requirements.

HUNTING DIGITAL MAPPING SYSTEM

MAP PRODUCTION



Figure

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3. Map production

As only eight of our twenty photogrammetric instruments are on-line, digital and conventional methods of map production have to co-exist side by side. No special section has been set up for digital mapping, which is produced in the same working areas as conventional mapping, and photogrammetric operators and draughtsmen are switched from one to the other deliberately. This increases variety and interest in the work and retains maximum flexibility in map production, which is essential for an international contract mapping organization. Projects are frequently produced partly by digital and partly by conventional methods to exploit the advantages of each.

Survey projects do not have to be planned for digital or conventional production until the photogrammetric plotting stage approaches, as the procedures for aerial photography, ground control and aerial triangulation are common to both. This enables us to select the projects which are better suited to one or other method of production, after we have examined the photography (Figure 3).

Initially, it was inconvenient to handle photography flown diagonally across the map format on the digital system but this problem has now been overcome by producing all plots in the final map sheet format. Ground control is computed with pocket or desk top programmable calculators and only large geodetic network adjustments are performed on the PDP 11/50 in background. The control data for each project is stored in the computer and can be recalled for aerial triangulation, and plotted on preparation diagrams and on the final maps with distinguishing point symbols for each category of survey station.

It is possible to observe aerial triangulation and capture graphic data in one operation at the A8s before the ground control data is available, as the model transformations can be applied after data capture. Contours would have to be generated by interpolation from observed form lines or spot heights requiring additional software. In the right circumstances this might be a practical way of reducing the time required to deliver urgent project mapping but there are practical difficulties in storing large quantities of unprocessed data.

Aerial triangulation is normally observed off-line by stereocomparator with punched tape output, as the quantity of data to be recorded in each model does not justify using the on-line system. The computations of relative orientation, strip and block adjustment are performed on the PDP 11/50 in background and the data retained in the control file.

Relative orientation elements and corrections for absolute orientation are calculated during aerial triangulation and listed for use both in conventional and digital mapping to obtain the instrument settings very rapidly. The relative settings often require no further adjustment. When capacity is available, the flatbed is used to plot grids and control for conventional mapping sheets which further reduces the preparation and total setting time.

For digital mapping, on-line assistance is also provided for scaling and levelling. Model coordinates of the control points are recorded and the corrections to be applied to the tilts and base setting are displayed on the screen. This is based on a least squares adjustment of any reasonable combination of horizontal and vertical control up to a maximum of 16 points. After introducing these corrections, the model coordinates are recorded again and further corrections can be made at the discretion of the operator, although this is rarely necessary.

The Z datum can be reset at any time, to allow for changing stereoscopic vision or change of operators, and the model can be reset, if for any reason it is disturbed. The plotting area of each photomodel is defined by preselected perimeter points and can be subdivided. Gears are selected to obtain a progress plot without grid or control points at an exact scale on the A8 table, usually at final map scale. The progress plot is produced primarily as a record of what has been digitised and is not tidied up in any way, al-

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though it is compared with the flatbed plot as a check against omission or corruption of data. By using stable material at an exact scale, it is possible to plot some features or some areas conventionally and the rest digitally and combine the two at the fair drawing stage. We find this mixture of techniques invaluable for contouring through dense vegetation, in flat featureless terrain and on very steep slopes where direct digitising in the stereoplotter is slow and unsatisfactory.

Data capture proceeds, by deliberate design, in a very similar manner to conventional plotting, although with experience specialised routines have evolved.

The model can be plotted feature by feature, or area by area, at the operator's discretion; but frequent changes of feature code are time consuming, as each change has to be entered at the keyboard. It is not necessary to remember the feature codes as these are displayed on the screen.

Contour and spot height values are recorded from the Z encoder direct, and all features are recorded in three dimensions. For plotting detail the operator has the choice of tracking features continuously with the floating mark, "flagging" critical points by stopping and releasing the footswitch momentarily, digitising discrete points, or using the straight line facility to connect points in the sequence in which they are digitised. A "proximity" message on the screen assists in closing loops within the tolerance set for the loop closure routine. Parallel lines are generated either by plotting the centre line or one edge.

Once a few adjoining photomodels have been captured, the data is processed progressively in background to perform the various cartographic enhancements already described in order to prepare the data for plotting, or to derive digital ground models, profiles, volumes or database files in the required format. The routines for filtering, curve fitting, edge matching, loop closure and rectangularity cannot conceal mistakes in the captured data as they operate within very small tolerances, usually around 0.1 mm at model scale, which can be varied from project to project. Larger mismatches are left to be investigated.

Pre-interpretation of road and vegetation classifications, single or parallel lines and the limit of imprecise features is advisable but it is not necessary to finalise the drawing specification for the map series until the data is ready for plotting on the flatbed. Each line feature is assigned a suitable line gauge and can be plotted in a wide range of styles - solid, pecked or, in the case of tree canopy, asymmetric. A large number of software symbols is available to represent point features and special symbols can be flashed with the photohead. Point features can be annotated and spot height values plotted. Areas can be annotated by recording a point at the selected position using the relevant line feature code. As these annotations and height values may clash with adjacent detail, they are often produced on separate overlays in urban areas to make it easier to reposition them by hand where necessary.

Diagrams and checkplots are plotted in ink in different line gauges and colours as required, and final plots are usually produced with the detail separations exposed on photographic film and the contours scribed. Sheets may be produced forward facing or mirror-reversed with up to 24 separations. Grids can be drawn at any angle to the sheet format, which must be rectangular but can overlap.

The same survey data can be replotted at other scales to entirely different styles of presentation with unwanted features omitted.

It was originally envisaged that ink checkplots would be produced in groups of photomodels for editing and correcting on the Freescan digitiser, before producing the final plots. In practice this has proved unnecessary for most projects as errors and omissions are few and can easily be corrected by draughtsmen on the final plots. Editing at the digitiser table is essential, if the digital data is required as an end-product.

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The digitiser table can also be used to add field verification and revision information and to digitise maps and drawings from other sources. This data can be processed and refined in the same way as data from the stereoplotters.

Copies of the plots are returned to the photogrammetric staff for checking and are passed to the draughtsmen to correct and complete the final drawings. Corrections to contours are easily made on the scribe-coated material. Detail separations are corrected and any imperfections are made good to achieve a high standard of cartographic presentation. Slope and rock symbols are drawn by hand; spot height values and annotations, which clash with adjacent detail, are repositioned. Names, grid and contour values are all added manually, as automated name placement is expensive and inartistic.

Finally, the draughtsman has to satisfy first himself and secondly the cartographic examiner that the final drawing looks like a map, not just a computer print out, and that it is virtually indistinguishable from a map sheet produced conventionally to the same specification.

Magnetic tapes of the digital data are retained for storage and retrieval and can be reprocessed to supply digital output to clients for their own data banks or as digital ground models for engineering design calculations. Scanning profiles could be interpolated for use with computer driven orthophoto equipment.

4. Production experience

The digital mapping system has now been in production for over a year and around 500 map sheets and a variety of digital products have been produced. The technical performance of the system is meeting most of our expectations but it will be some time before an assessment can be made of its financial performance compared with conventional methods.

Mapping has been produced at scales ranging from 1:500 to 1:10 000 covering both urban and open areas, but larger and smaller scales will be attempted when the need arises. Mapping at 1:500 has been successfully replotted on the flatbed at 1:1000 and 1:2000 scales; 1:2500 scale mapping has also been reproduced at 1:5000 and 1:10 000 (Figures 4, 5 and 6).

Two times reduction from large scales presents no difficulties, with the smaller features not normally shown at the reduced scale being omitted. Four or five times reduction usually requires some preliminary testing as, even after omitting small features, some essential features tend to merge or collapse. Minor problems can be corrected by hand afterwards, but it is often more satisfactory to print those detail features which can be used direct on one separation, and all other features on a second separation which is made good or redrawn conventionally. Contours reduce more easily by selecting the contour interval and index contour values suitable for each scale of mapping. With no software for generalisation, we had not expected large reductions to be as successful as they have proved.

A high standard of cartographic presentation is achieved, within the range of scales described with only a small amount of embellishment by hand. This reflects the effectiveness of the filtering and curve fitting routines and the various cartographic enhancements. The procedure for generating parallel lines is particularly successful as the example (Figure 7) shows. The rectangularity routine squares up simple individual buildings but cannot assist in aligning separate buildings or a complex group of attached buildings. Part of the problem is that there is a tendency with conventional mapping to represent man-made features as the planners hoped they would be rather than as the builders constructed them. Conventional mapping often makes the world seem more formal and geometric than it really is, whereas digital mapping presents an unbiassed, if less pleasing, appearance. Such differences are very small and the final map, after it has been corrected by the draughtsman, is indistinguishable to the user from conventional maps. This is essential to us, until we can educate our clients otherwise, as we must be able

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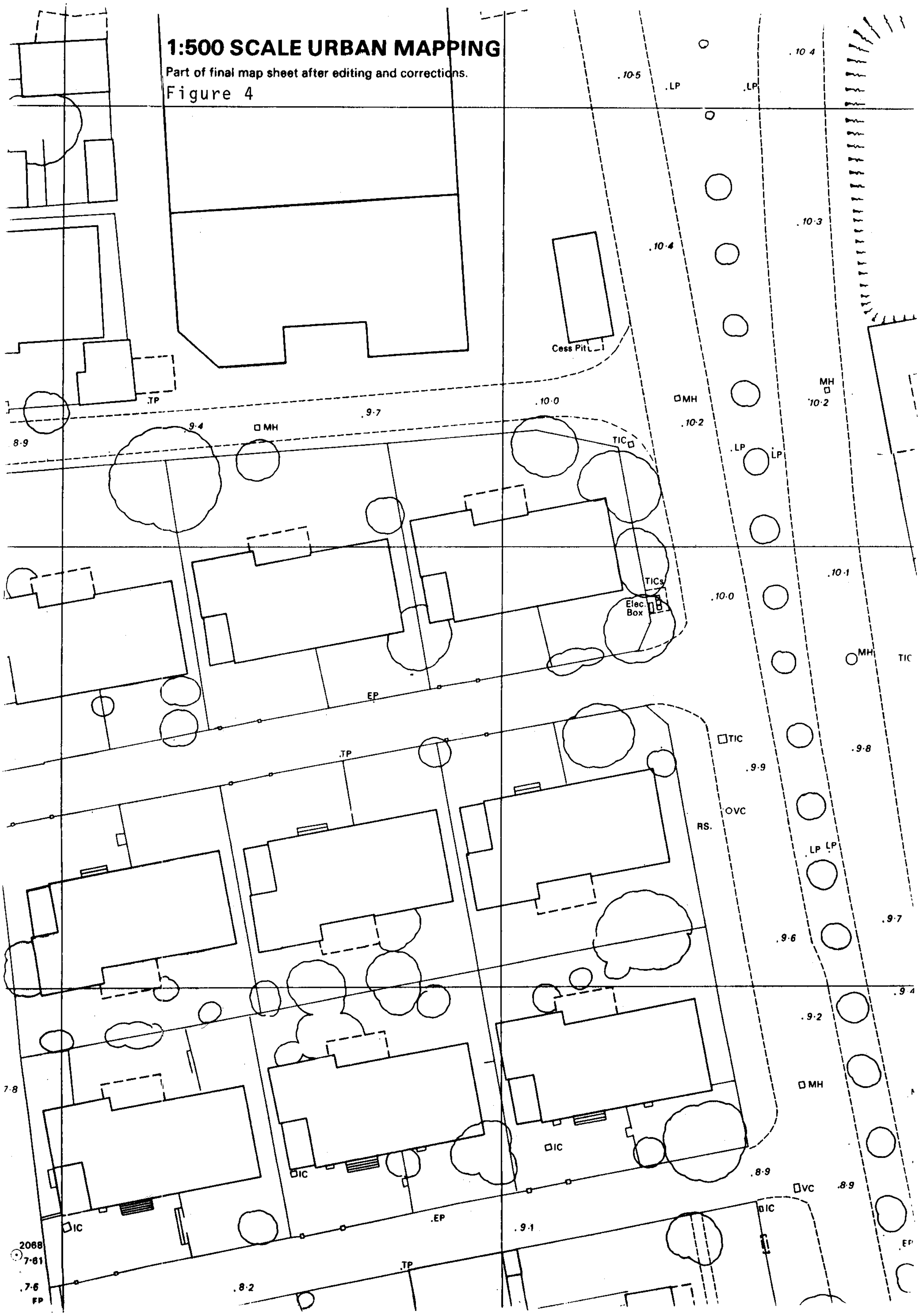

1:500 SCALE URBAN MAPPING

Part of final map sheet after editing and corrections.

Figure 4

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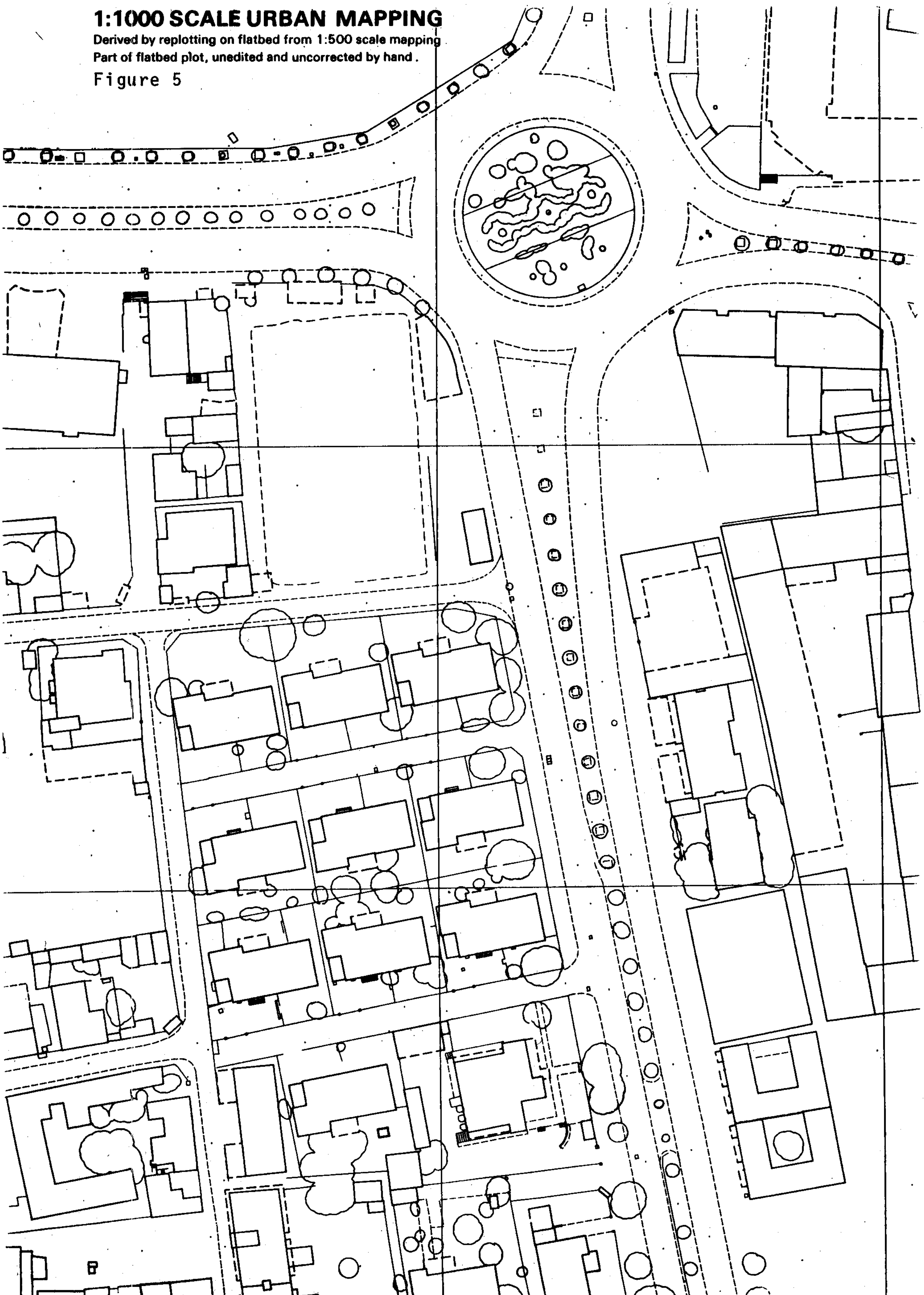
1:1000 SCALE URBAN MAPPING

Derived by replotting on flatbed from 1:500 scale mapping.
Part of flatbed plot, unedited and uncorrected by hand.

Figure 5



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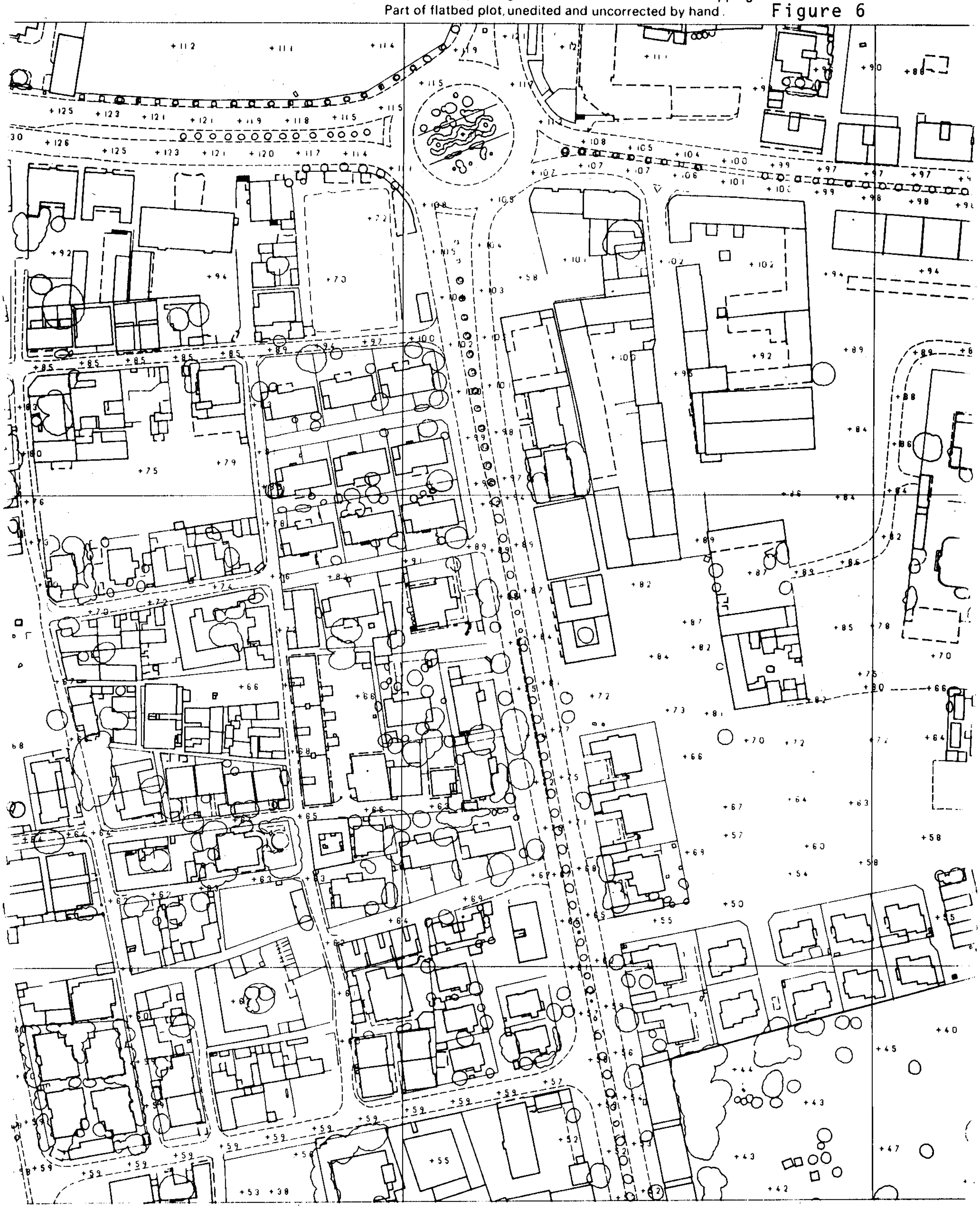
1:2000 SCALE URBAN MAPPING

Derived by replotting on flatbed from 1:500 scale mapping.
Part of flatbed plot, unedited and uncorrected by hand. Figure 6



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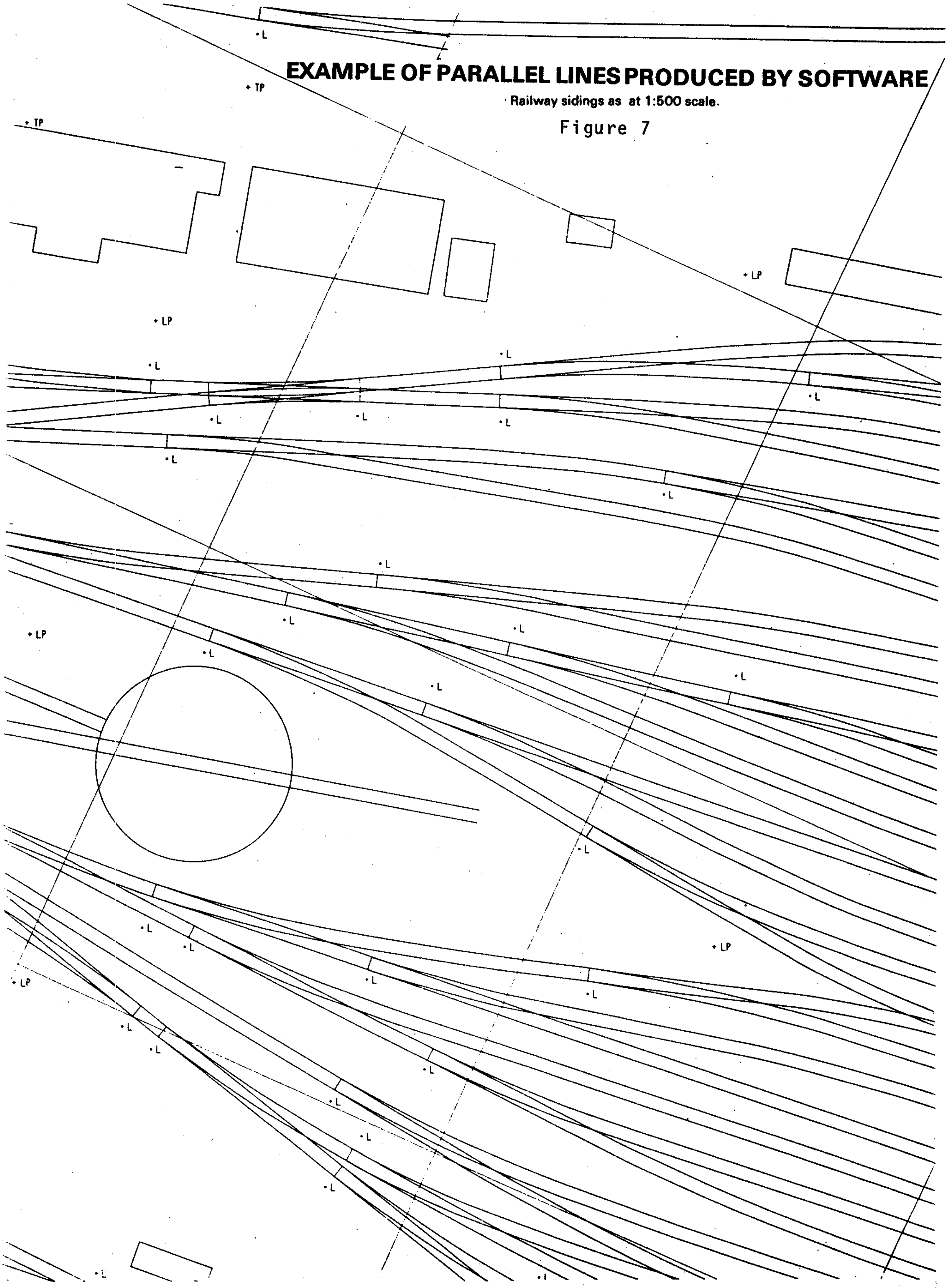
EXAMPLE OF PARALLEL LINES PRODUCED BY SOFTWARE

Railway sidings as at 1:500 scale.

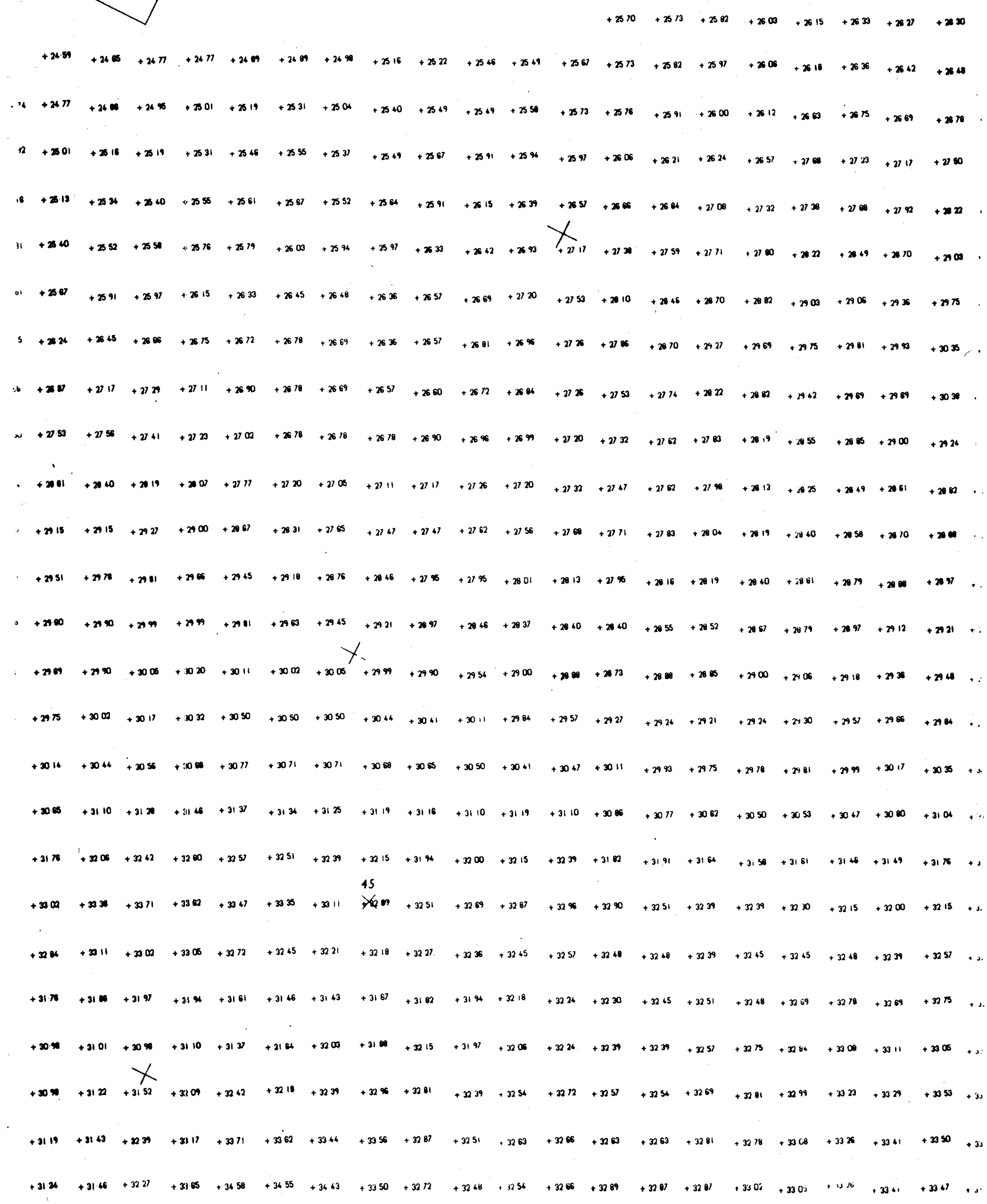
Figure 7



OBSERVED GRID OF HEIGHTS

1:500 scale flatbed plot of heights observed at 5m intervals from super wide angle photography using enlarged diapositives.

Figure 8



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to match the style of presentation of existing map series, produce urgent project mapping partly by digital and partly by conventional methods, and produce individual sheets by a mixture of the two techniques.

The accuracy of the digitally-produced maps is well within normal mapping specifications: whether it is better or worse than conventional mapping is more difficult to assess - it is certainly different. The location of the floating mark in the stereoplotter is reproduced in the final map with significantly greater accuracy and reliability than is usually possible by conventional orientation, mechanical enlargement, touching-up and re-drawing. This has not yet tempted us to advocate bigger enlargement from photograph to map scale or the use of bigger C-factors for contouring - matters on which we are proud of our reputation of extreme caution. The quality of the photographic image and the accuracy of identification of topographic features in the photomodel, upon which both methods depend, is no different. The operator is required to maintain consistent reliability for long periods, without breaks to touch up the manuscript. With conventional plotting, the corner of a building which is obscured by trees can be constructed on the plot and the occasional incorrect pointing is immediately obvious and can be re-observed and corrected while the photomodel is still in the instrument. Such problems are more difficult to overcome with digital mapping systems. Interactive graphic display screens at each instrument would be prohibitively expensive and would only provide a partial solution. In practice difficult features are plotted precisely on the progress plot and either digitised or redrawn by hand.

Contours in open country are digitised neither faster nor slower than conventional by plotting but as they can be scribed at any reasonable scale with minimal hand corrections other than the addition of contour values, the saving in draughting hours is substantial. In thick vegetation, on very steep slopes and where the photographic model lacks surface texture, the operator needs to search ahead and select the alignment after several trials. Despite the "delete" facility, we have found it quicker and more satisfactory to add contours in such areas conventionally as the results produced by the system have to be rescribed by hand in any case.

The system is also used to produce digital output either as by-products or as the primary purpose. There is already some demand for data to be supplied to users on magnetic tape in a format compatible with their individual database requirements and for further processing. Regular grid digital ground models can be observed with instantaneous registration and can be plotted out on the flatbed and supplied to the user on magnetic tape, punched tape, or cards. The example (Figure 8) shows a close grid of spot heights observed from super wide angle photography, using diapositives enlarged to 100 mm focal length. Profiles and cross-sections can be plotted on the flatbed as elevation drawings.

Periodic measurements of coalstocks are now entirely observed and calculated using the system, which halves the observing time compared with our previous procedure using EK5 registration units, and gives faster delivery of results with improved accuracy and reliability checks. More than 80 coalstock measurements have been processed through the system in the last year.

The system has not yet been used for terrestrial applications as we prefer to use the larger instruments such as the Wild A10, A7 and A5 or the stereocomparator for this purpose. Provided the camera tilts are within the range of the relative orientation elements of the A8s, the absolute orientation could be achieved by computation which may prove useful particularly with large common tilts.

Large on-line systems with a single central processor are vulnerable to software and hardware failures, and we have had more of these than we believe we deserved. Even so we remain convinced of the advantages of low cost compared with individual on-line processors. The high rate of data capture, coupled with real time filtering to discard surplus registrations, and powerful cartographic refinements, produce a quality of presentation and accuracy which off-line systems seem unlikely to be able to attain.

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To be commercially viable the system must make substantial savings in man hours compared with conventional procedures. It is also an advantage to be able to produce the final maps more quickly, which is a benefit to the user, reduces the cost of financing work in progress and releases additional production capacity. Digital by-products and new types of data output are extending the applications of the system beyond the scope of traditional surveying and mapping techniques into general data processing. The computer, the digitiser table and the flatbed plotter are already being used for processing data not directly related to the digital mapping system.

Even after a year of limited production, it is evident that the system is beginning to achieve all of these objectives to some degree. Savings of man hours are particularly apparent in setting photomodels, observing coalstocks, grid DGMs and profiles, and in the much reduced drawing effort. By carefully selecting the type of work, significant savings in photogrammetric plotting time can also be achieved. Checking and editing off the instruments does take longer but is a small part of the total. The saving in drawing effort to reproduce maps at several scales is much greater than we anticipated.

Digital mapping complements rather than replaces conventional methods. This system has been designed to be compatible with conventional procedures, which enables us to use both methods of production to their best advantage, mixing the two techniques if necessary. Ultimately, it is not the machines and the computers which make the maps but the people who operate them. The digital mapping system is operator-controlled throughout. Discrepancies outside very small tolerances (around 0.1 mm at photomodel scale) are never removed automatically but are left to be investigated. Anyone who imagines that computer-assisted mapping systems require less experienced staff should think again, for the reverse is the case.

We are fortunate in having experienced, cooperative and tolerant staff, who have endured the frustrations and failures during development and have been constructively critical of the shortcomings of the system. The production routine has changed considerably since it was first introduced as a result of practical suggestions made by staff at all levels. Without the technical and organisational expertise, and above all the enthusiasm to make it work, no digital mapping system could succeed.

ACKNOWLEDGEMENTS

The enthusiasm and determination to develop this digital mapping system were Peter Mott's. The mathematical basis and the detailed specifications were the work of Kenneth Keir. SPL International Limited were employed first to undertake the feasibility study and then to install the hardware and develop the software to implement the system. Mary Harrington advised on operational aspects to ensure that the system would be efficient in production. Staff in all the mapping departments have contributed and continue to contribute ideas to improve the design and operation of the system and have made it work.

Reference

K.M. Keir: "A Digital Mapping System designed for the Commercial Air Survey Market". XIII Congress of the International Society of Photogrammetry, Helsinki 1976.

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Abstract

The paper describes the performance of the Hunting Digital Mapping System in production.

The system consists of a central processor on-line to eight stereoplotters, a digitiser table and flatbed plotter, and is controlled by a real time operating system designed for the purpose. The computer is also used to adjust geodetic networks and blocks of aerial triangulation and for other processing in background.

A wide range of mapping between 1:500 and 1:10 000 scales and various types of digital data output have been produced in the first year of production and additional applications are continually being developed. The high standard of cartographic presentation, which is virtually indistinguishable from conventional fair drawn maps, makes it possible to match existing specifications and undertake mapping projects partly by digital and partly by conventional methods.

A preliminary assessment is given of the technical performance and cost-effectiveness of the system after the first year of operation.

Zusammenfassung

Der Vortrag berichtet über den Produktionseinsatz des digitalen Kartierungssystems von Hunting.

Das System besteht aus einem zentralen Prozeßrechner, der on-line an 8 Stereoplotter angeschlossen wird, aus einem Digitalzeichentisch und einem Flachbettzeichentisch. Es wird von einem eigens für diesen Zweck entwickelten Echtzeit-Betriebssystem gesteuert. Außerdem dient der Computer zur Ausgleichung von geodätischen Netzen und Triangulationsblocks sowie zu zusätzlich anfallenden Berechnungen.

Im ersten Einsatzjahr wurden ein großer Kartierbereich vom Maßstab 1:500 bis 1:10 000 und verschiedene Arten der digitalen Datenausgabe geschaffen. Zusätzliche Anwendungsbereiche werden fortwährend entwickelt. Die hohe Qualität der kartographischen Darstellung, die von konventionellen Reinzeichnungen praktisch nicht zu unterscheiden ist, ermöglicht es, vorhandene Spezifikationen einander anzugleichen und Kartierungsprojekte teils mit digitalen, teils mit konventionellen Methoden durchzuführen.

Es wird eine vorläufige Beurteilung der technischen Leistung und der Kosteneffizienz des Systems nach dem ersten Jahr des Einsatzes gegeben.

Résumé

La conférence a pour thème la performance du système digital de restitution de Hunting, en pratique.

Le système se compose d'un calculateur processeur central branché en on-line à huit stéreorestituteurs, d'une table de numérisation et d'une table traçante. Il est commandé par un programme de fonctionnement en temps réel développé spécialement dans ce but. Le calculateur permet d'autre part de procéder à la compensation de réseaux géodésiques et de blocs d'aérotriangulation et à différents calculs additionnels. De nombreuses restitutions ont été effectuées à des échelles situées entre 1:500^{e} et 1:10 000^{e} au cours de la première année d'exploitation, de même que différents types de restitution digitale. De nouvelles applications sont en cours de développement. La grande qualité de la représentation cartographique qui ne présente aucune différence avec les cartes obtenues par tracé conventionnel, permet d'égaliser les spécifications déjà existantes et de réaliser des projets de restitution, en partie suivant des méthodes digitales et en partie suivant les méthodes conventionnelles.

La conférence donne une analyse préliminaire de la performance technique et de la rentabilité du système sur la base de l'expérience acquise au cours de cette première année d'exploitation.

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Resumen

En la presente conferencia se informa acerca del uso productivo del sistema de restitución digital de Hunting.

El citado sistema consta de una computadora central de proceso conectada en línea con ocho estereorrestituidores, una mesa de digitalización así como una mesa de dibujo plana y se manda con ayuda de una operación en tiempo real, especialmente desarrollada para esta finalidad. La computadora se utiliza asimismo para la compensación de redes geodésicas y bloques de triangulación aérea y para llevar a cabo otros cálculos adicionales.

En el curso de su primer año de empleo, se han efectuado una gran cantidad de restituciones con escalas comprendidas entre 1:500 y 1:10 000 almacenando a la vez datos digitales de índole muy variada. Continuamente se están proyectando aplicaciones adicionales de este sistema.

La alta calidad de la representación cartográfica que efectivamente no se distingue de los dibujos en limpio obtenidos por vía convencional permite cumplir con signos convencionales existentes y llevar a cabo restituciones, en parte digitalmente y en parte por métodos convencionales.

Se hace un análisis preliminar del rendimiento técnico y de la rentabilidad económica de este sistema, a base las experiencias ganadas al cabo de un año de funcionamiento del mismo.

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