Map completion techniques for small scale mapping

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Abstract

This paper outlines the map completion techniques currently applied to the National Topographic Map Series 1:100,000 and 1:250,000 maps produced by the Division of National Mapping, and presents:

- the office preparation and pre-field inspection procedures and techniques of updating original compilations using the latest aerial photography.
- an explanation of aerial and ground inspection methods and nomenclature checking;
- finalisation of the compilation.

Introduction

The Division of National Mapping, Dandenong office, is responsible for the compilation, completion and revision of 1:100,000 and 1:250,000 National Topographic Map Series (NTMS) maps over a large part of Australia.

First Edition base compilations may be photogrammetrically plotted or derived from existing larger scale maps. The map completion exercise is aimed at the ensuring that the map compilation agrees in all material ways with ground truth, that photo interpretation is correct, that roads are correctly classified both by surface and use, and that the map is complete and up to date at the time of compilation.

Map Revision is a similar task, but differs in that we are dealing with the update of existing 1st and subsequent edition maps. It will almost certainly involve using the map completion techniques particularly if the revision calls for a completely new compilation from new air photography.

This paper deals specifically with the completion of 1st edition maps and the techniques used may vary according to circumstances. In general, they are designed specifically for 1:100,000 scale, as all sheets, regardless of publication scale, are presently compiled and completed at 1:100,000 in 1:250,000 blocks, Within the next few years, we will commence compilation, but not publication, at 1:50,000 when such scale is required for national development or defence needs.

Pre-field preparation

COMPILATION UPDATE

The base compilations will have been prepared either by steroplotting from existing standard photography or by derivation from existing larger scale maps.

Before doing the field inspection, a pre-inspection up-date is attempted. For this, any available reference material is used and may comprise:

- varying scale special purpose maps; and
- later and/or larger scale aerial photography.

If for some reason the base compilation was compiled some years previously and there is reasonable expectation of significant and wide spread development, new standard photography may be flown and used with the existing model control to a comprehensive update. This new photography is at a scale of approximately 1:80,000 and is usually black and white, although false colour infrared has been used in some areas. (This was especially true in the Balranald and Deniliquin 1:250,000 areas to avoid the problems of interpreting the many water features and rice fields in the area. Sealed roads also stood out well).

Completion techniques, in the main, involve detail amendment directly on the original compilation sheet.

The latest photography is thoroughly examined for additional detail, which is annotated in ink and plotted onto the compilation sheet using either the Bausch and Lamb Differential Stereoscope, the Zoom Transfer Scope (ZTS) and/or the B8 and PG2 stereoplotters.

The ZTS is used to plot new detail onto the compilation using existing features for scaling and control. The Bausch and Lamb is used to plot new detail onto a stable base orthophotomap by using image correspondence.

Both techniques are only suitable in flat terrain with the detail being transferred confined to the area of the small field of view. Sufficient points of existing detail should appear on the photography and on the compilation to allow for accurate scaling.

In areas of relief and little available detail as control, the partially annotated photography is placed in a B8 or PG2 stereoplotter. Using the original model control, and scaling to corresponding points on the compilation sheet, the new detail is accurately plotted.

In the B8 and PG2 method of plotting new detail, precise levelling is not necessary and set up times are relatively short. The stereoplotting update has several advantages over the techniques used in flat terrain:

- height displacement errors are eliminated.
- the operator has more points to select and check for scaling; and,
- complete ink annotation of the photography is not necessary.

The main problems with the ZTS method are:

- the necessity to ink up new detail and existing detail for scaling in and transfer;
- height displacement errors could occur in inking over the photography; and,
- the difficulty in plotting simultaneous photo/map image.

During the plotting, continuous reference is made to all available maps and plans ordered through the Division's Geographic Branch or requested from other mapping agencies, Shire Councils, and Land Agents.

Being satisfied that all new detail has been added, the plotter inks up all new linework, adds all "rub-down" symbols, carries out deletions, and ensures that any features that caused photo interpretation problems are clearly marked for resolving in the field.

Field inspection

Within the Division of National Mapping, a field inspection survey for 1:100,000 map verification consists of:

- pre-inspection planning;
- aerial inspection of ground detail

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compared with detail shown on the compilation;
- ground inspection of selected detail shown on the compilation;
- classifying roads according to function and surface;
- planning supplementary photography, if required;
- gathering names and verifying existing names.

PRE-INSPECTION PLANNING

A Project Surveyor is responsible for the preparation and planning of materials for field inspection.

Preparation

On receipt of the updated compilations or edited replots, the decision is made as to what form the aerial inspection sheets will take. The form could be either a paper dyeline of a line map or an annotated orthophotograph. The choice depends on several factors.
- the type of country to be inspected;
- the amount of detail;
- the problems that could be encountered during navigation;
- the clarity of the detail and the quality of linework of the compilation.

In areas of little cultural detail an orthophotograph may be used. The natural features of the terrain are then used as the basis for navigation. This was especially so for the desert areas of Australia, where the natural pattern of sandridges and numerous dry lakes were predominant both on the ground and on the orthophoto.

In the majority of areas, paper dyelines of each of the compilations has proved to be satisfactory as well as economical.

The use of colour proofs is restricted due to the financial costs involved and the time taken to produce them.

Planning

Following the decision to field complete the given 1:250,000 map blocks, the Project Surveyor completes the following:
- sets the field inspection dates with considerations given to the expected time of completion of Office update;
- requests the appropriate aircraft and vehicles for ground inspection;
- calculates and arranges finance for allowances, petty cash, supplementary photography expenses, and costs to repairs and maintenance of vehicles;
- arranges accommodation for field personnel;
- determines aerial inspection flight line separation and direction;
- writes to the Surveyor General of the State in which the sheets fall, indicating intention to survey;
- requests a listing of approved and "official" names from the State Nomenclature Board, and;
- writes to District Offices and Shires for information on Council maintained roads, surface type and whether they are for public or "other" (private) use.

These tasks are completed at various intervals in time between the decision to map complete and the projected date of departure for the survey area.

AERIAL INSPECTION

General procedure

An aerial inspection of ground detail is made over the whole map sheet. The ground detail is compared with that shown on the inspection sheet and errors and/or omissions are noted. Doubtful identification of detail at the plotting stage can be resolved and road surface classification confirmed.

Aircraft requirements

The aircraft must be high winged and is usually a single engined aircraft. It should have a camera port modification to house a 70mm Hasselblad camera, and a suitable navigation device such as a drift sight.

The flight crew consists of a pilot and two observers. The observers are seated on opposite sides of the aircraft in order to cover the maximum area in each run. Each observer has an aerial inspection sheet, suitable "non-smudging, permanent" ink pens, and binoculars.

Operational procedure

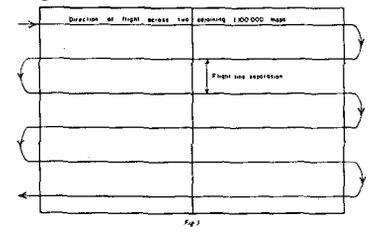
Prior to the inspection flight, the flight lines are marked on each of the compilation dyelines and one 1:250,000 (for the pilots use in navigating). The roads and tracks are highlighted to aid navigation and interpretation.

Additional ground detail obtained from Shire plans and Land Agent plans is transferred to the aerial dyelines as added detail for confirmation, or deletion. Inspection runs are carried out at a flying height of 1520 metres (5000ft) above mean terrain. The inspection is carried out on a grid pattern using either NS or EW flight lines.

The distance between flight lines will be determined by the density of detail on, or expected to be on, the sheet (usually between 5000 and 7000 metres) and the height of the terrain.

Each observer familiarises himself with the sheets to be inspected, and in particular, notes all I.D.'s (Interpretation Doubtful), P.D.'s (Position Doubtful) and E.D.'s (Existence Doubtful) on the sheet, marking them for ready reference during the flight. Variations from this pattern, including circling and banking for a better view, can be made where necessary. Each flight line is flown once and in the opposite direction to the one proceding it. The "one line" time to inspect these sheets is usually between four and five hours.

Experience has shown that the best utilisation of the aircraft is obtained by inspecting two adjoining map sheets in one flight — the flight lines being continuous over the two sheets. See figure 1.



The speed of the aircraft should be as slow as necessary for the observers to confidently plot the relevant ground detail, and would normally be related to the density and complexity of ground detail. A speed of about 90 knots is normally most suitable. Each observer inspects the ground detail that passes beneath his side of the aircraft and compares it with the detail shown on the dyeline. One of the main roles of the observer is to eliminate interpretation errors and these should be clarified as well as sketching extra detail and deleting detail which no longer exists. All corrections are made to the dyeline in flight as accurately as possible. Any feature which are not identifiable from the air are checked on the ground. Road classification is checked from the air and on the ground.

GROUND INSPECTION

The amount of ground inspection per sheet depends on the density of the detail in the area to be inspected. Features which are not identifiable from the air are generally inspected on the ground using either 2 wheel drive or 4 wheel drive vehicles — a driver and observer in each vehicle. The observer uses a dyeline of the compilation as a guide to navigation to and from feature/s in question, as well as to add new features and verify and/or amend existing detail. Any further information regarding errors in interpretation, extra detail, and detail which no longer exists, is noted on this dyeline. The detail is colour marked on the aerial inspection sheets. The information gathered in the air is collated onto a dyeline called the Field Inspection Sheet which shows the detail to be added or deleted from the original compilation.

If aerial and ground inspection information differ, the ground inspection decision takes precedence. As for aerial inspection, the detail information gathered during ground inspection is collated onto the Field Inspection Sheet.

ROAD CLASSIFICATION

Within the Division, roads are classified as either "Public" or "Private", according to function and surface. Information on public roads is supplied by the Division's Geographic Branch and by local Shire Councils and State Government bodies. Private roads are those roads or tracks which do not form part of the public communication system,

where access may be restricted. The surface classification of these roads is verified during ground inspection — the difficulty being the distinction between Public or Private road.

NOMENCLATURE CHECK

Feature names, both cultural and topographic are gathered and/or conformed where possible. The source of such names is always quoted using a number referencing system. Local government or semi-government organisations have proved to be a reliable source of information.

All names and their source code number, are collated onto a compilation dyeline called the "Nomenclature Sheet". Names are cartographically positioned such that this sheet can be used as a guide for placement using the Digital Mapping System during office finalisation.

SUPPLEMENTARY PHOTOGRAPHY

On completion of the aerial and ground inspection, the extent of any development, subsequent to the original compilation photography, is assessed using the Field Inspection Sheet as a guide.

Where there is new detail to be added, a twin-engined aircraft equipped with a camera port and drift sight, is used to take 3050-4600 metre RC 9 photography. Supplementary photography is not flown strictly to the specifications for vertical photography, but flown specifically to cover the map completion detail to be added; i.e. it is not flown strictly EW or for block coverage, and can be flown to cover isolated features or to follow a single linear feature such as a track or fence.

In areas where there is little change and a minimum amount of new detail, the inspection aircraft is used to take 1520 metre 70mm format supplementary photography. The features to be photographed are few in number and consist of small and isolated features.

However, some of the features picked up during aerial and ground inspection are actually on the latest photography, but have been overlooked (or misinterpreted) during plotting, but once pinpointed, are readily visible.

The supplementary photography is processed, annotated and printed. Key diagrams are prepared on a 1:250,000 base map, and used as a guide for the compiler during office finalisation of the compilation.

Office finalisation

The compilation sheets are amended using the Field Inspection Sheet as a guide to additions, deletions or amendments. New or altered detail is annotated on the supplementary photography and transferred to the compilation sheets using the ZTS or B8 and PG2 stereoplotters. New detail is added using existing map detail as control.

Depending on the density and complexity of cultural and drainage detail, names are either added to the compilation itself, or to a pre-punched registered drafting film overlay.

Currently, the Division is experimenting with digitising names at scale of 1:250,000 using the Digital Mapping System. The names for the individual 1:100,000 sheets are regenerated from the 1:250,000 names data base. As a "by-product" of this system, a complete list of names with geographical co-ordinates source, reason for deletion etc., is available in 'hard-copy' form.

Summary

Under the present project team concept the time between finalisation of the compilation and fair drawing has been shortened considerably. This is highly desirable, as the map reliability date is the date of field inspection and the printed map starts to go out of date from that time.

During the plotting of the base compilations, as much detail as possible is plotted without causing clutter and confusion, enabling the observers to concentrate on interpretation errors rather than having to position new detail. It is far easier, during aerial inspection, to delete a feature from the compilation than to detect and indicate a new one.

The tendency at present, for map completion plotting, is for experienced machine operators and photo interpreters to use stereoplotting instruments in all but very flat terrain. Accepting that the original plot is within accuracy specifications, and new detail is plotted accurately using existing detail as control, the accuracy will be maintained to a standard suitable for later revisions.

As digital mapping techniques and remote sensing techniques are further developed, current procedures will no doubt be modified to further increase the efficiency of the total operation of compiling, producing and maintaining realiable map coverage of Australia.