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Commission IV / 2

Revision of Topographic Maps --

Results of the Fribourg Test by Commission D of the OEEPE

Paper presented by Commission D of the OEEPE

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Abstract:

Seven European national mapping organisations participated in a map revision test designed by Commission D of the OEEPE in 1976. Various photogrammetric and cartographic techniques (stereoplotting versus orthophoto method, drawing versus scribing etc.) were used to up-date the same 1:25 ooo topographic map of a suburban area in Fribourg/Switzerland. The results of the verification of these test samples in terms of accuracies, completeness and time involved in the different sub-processes are presented in a summarized version of the final report on this experimental work.

Zusammenfassung:

Sieben europäische Landesvermessungsämter beteiligten sich an einem Versuch über Methoden der Kartennachführung, der 1976 von der Kommission D der OEEPE in die Wege geleitet wurde. Derselbe Ausschnitt aus einer topographischen Karte 1:25 ooo der westlichen Vororte von Freiburg/Schweiz wurde unter Anwendung verschiedener photogrammetrischer und kartographischer Techniken (Stereoauswertung im Vergleich mit Orthophotoauswertung, Zeichnung mit Gravur) nachgeführt. Der Bericht ist eine gekürzte Fassung des Schlussberichtes.

Goals of the Fribourg Test on Map Revision

This preliminary report on the Fribourg test of Commission D of the OEEPE gives an idea of the map revision procedures actually in use or in consideration in some countries of Western Europe. It has been recognized from the beginning that the selection of an appropriate map revision process has to take account of a number of different criteria within the individual organisation itself, as e.g. personnel structure, available equipment, existing map bases etc. The major goal has been to disseminate information about current map revision systems and their individual processes and to assess their advantages and disadvantages. On the basis of this information, new revision methods for topographic series could be established or existing ones improved.

The Fribourg test consists of a comparative study of the entire map revision procedures at the scale 1 : 25 000 employed by the seven participating mapping organisations on one common topographic map extract. The test area chosen was the western suburbs of the town of Fribourg with about 20% of residential, 5% industrial, 60% agricultural area and 15% of woodland. The map extract comprises an area of 3,650 by 5 km or 18 km^2. This region is mostly hilly.

The Original Base Map and the Photography used for this Test

The sheet selected from the Swiss National Map Series 1 : 25 000 had been revised already once in 1968. The test area was covered by one model at 1 : 30 000 and by three or four of them at the image scale 1 : 18 000. Signalized pass points were provided to those centres that asked for. The image material used in the test was flown in 1976 with a wideangle lens (WILD UAg II) on a RC 10 camera by the flight organisation of the Federal Directorate of Cadastral Surveys in Berne. The Federal Office of Topography in Wabern-Berne processed the films and paper copies and sent to each participant 6 colour separation positive films of the base map.

Fig.1 Map Revision Test Area in the Suburbs of the town of Fribourg; Combined Base Map of the Sheet Fribourg 1:25 000 of the Swiss National Map Series, edition 1968, that had to be revides by the Participants

Participation and Methods used

The following methods were applied by the mapping organisations participating in this test:

Name and country	Image scale	Number of models	stereoplotting orthophoto method	scribing drawing
National Geographic Institute of Belgium	1) 1:18 000	4	stereo	scribing
	2) 1:30 000	1	stereo	scribing
Geographical Survey of Norway	1) 1:18 000	3	stereo	scribing
	2) 1:30 000	1	stereo	scribing
National Board of Survey, Finland	1) 1:30 000	1	stereo	drawing
	2) 1:30 000	1	ortho	drawing
	3) 1:30 000	1	stereofacet plotter	--------
State Survey of Baden-Württemberg, FR Germany	1:30 000	2	ortho	drawing
Institute for Applied Geodesy, Frankfurt FR Germany	1:30 000	1	ortho	scribing drawing
Topographic Service Delft, Netherlands	1:30 000	1	ortho	scribing
Federal Office for Topography, Switzerland	1:30 000	1	stereo	scribing

The participants were asked to send back 6 completely revised colour separation films, thus including photogrammetric as well as cartographic work.

Two Samples of Sequences of Procedures applied in the Map Revision Test

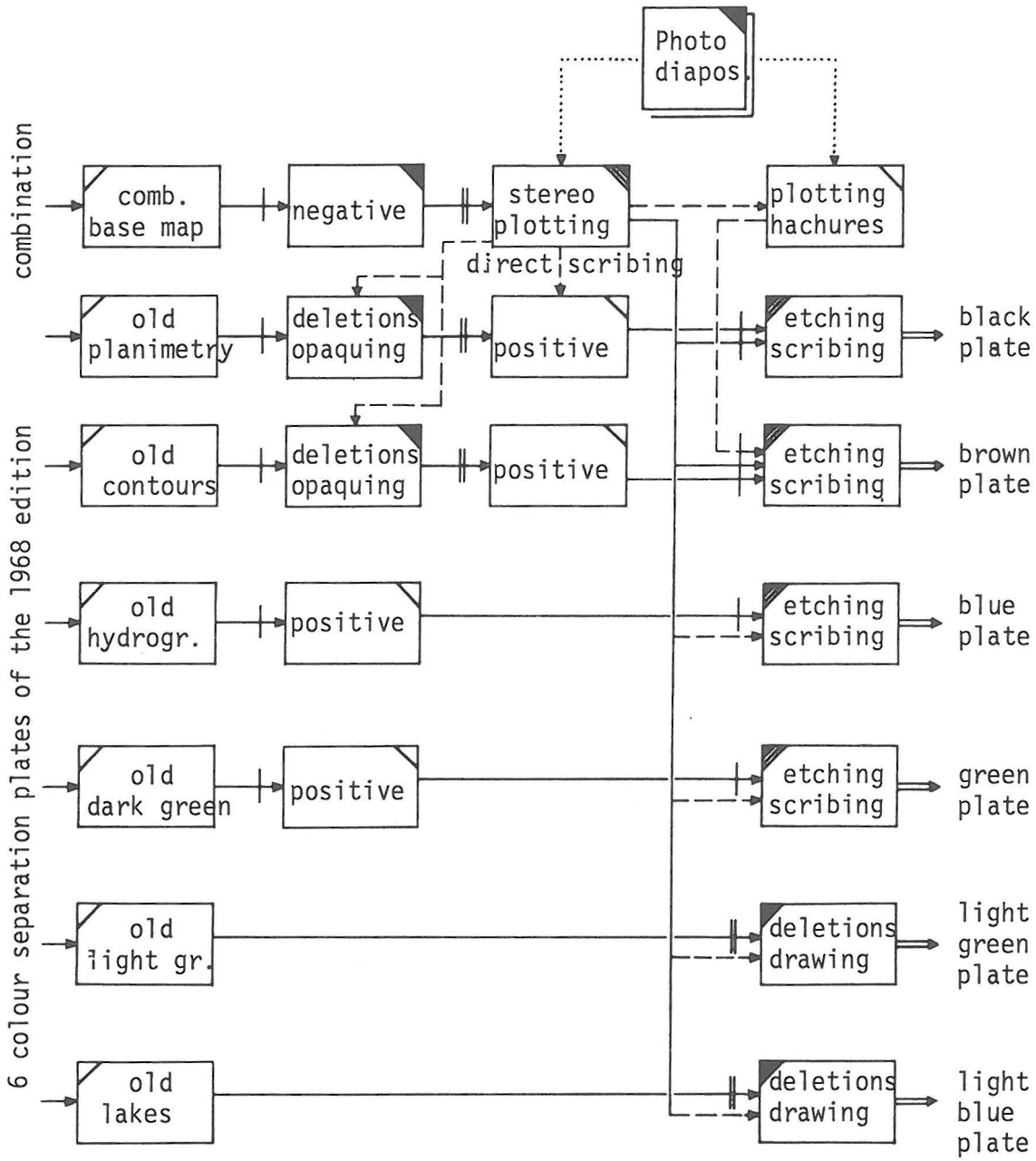
Out of all 11 test samples we choose here two of them only. All others will be included of course in the final report of this test. The two samples we give here contrast in the plotting technique used, as well as in the cartographic and reproduction procedures.

In one of the two tests executed by the Geographic Survey of Norway in Oslo one model at 1 : 30 000 image scale was stereo plotted at the scale 1 : 25 000 by direct scribing on a Keuffel and Esser Stabilene scribe coat on which a red guide copy of the combination plate had been copied using the Kwikproof process. All films received were prepunched for registration. Photo-interpretation was done by the operator while plotting. Apart from the road classification, no other field reconnaissance was used. The outlines of embankments and cuttings were plotted however in pencil and drawn afterwards in ink on a polyester sheet in register with the plotting manuscript.

From the original wrong-reading positives of the black and the brown plates, photographic contact negatives were prepared. Details to be deleted were opaqued on these two negatives by reference to the plotting manuscript. These negatives were then copied to positives that contain the remaining details. Then they were etched through a Stabilene rust scribe coat. A blueline guide copy was then applied onto the same scribe coat. The new map details for the black plate could then be scribed onto this scribe coat fitting with the etch of remaining map elements. Similarily the brown plate was processed, including the hachures. In principle the same procedure was applied also for the drainage and the vegetation plate, but due to the few elements to be added, no guide copy had to be made in these cases.

With all these revised scribe coats and negatives of the two tint plates a colour proof was produced on white opaque Stabilene using the Kwikproof process. As a result of proof reading, corrections were made directly on the above reproduction negatives, which were then ready for printing. Figure 2 shows the reproduction diagram for this sequence of procedures.

Fig.2 Reproduction Diagram of the Map Revision Procedure applied by the Geographical Survey of Norway: Stereo plotting from 1:18 000 or 1:30 000 imagery and scribing at 1:25 000



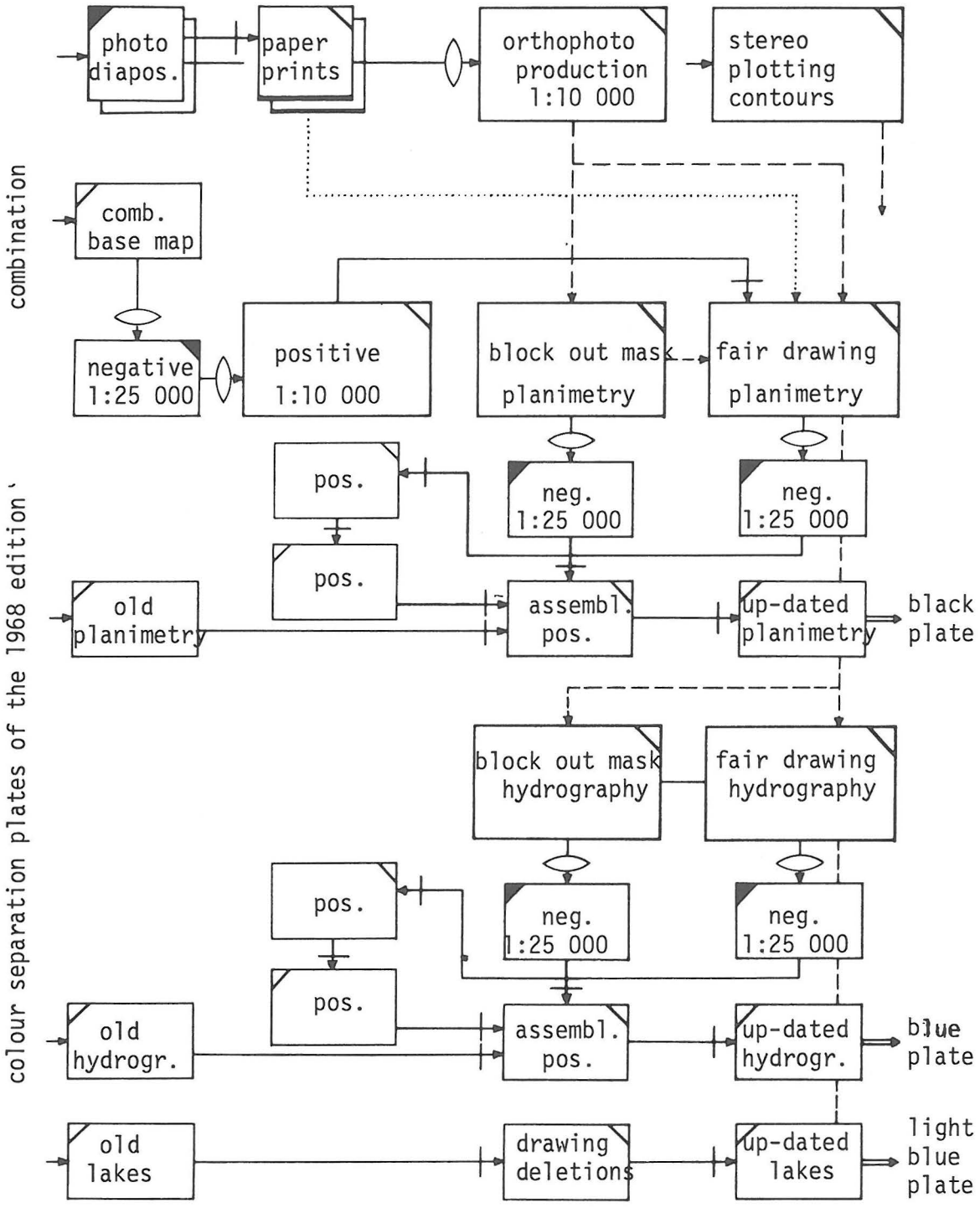
A completely different approach was used by the State Survey of Baden-Württemberg in Stuttgart (FRG). Three pictures at 1 : 30 000 were chosen for the orthophoto production in the Zeiss Planimat D 2 with storage and reading device. Profiles were scanned with a slit length of 4 mm. Time for scanning and producing the orthophoto positive at the scale 1 : 10 000 was about 5 hours. A negative of the combined base map was enlarged in the camera to the scale 1 : 10 000 and copied in blue on the back of a sheet of Pokalon, a 0.14 mm polycarbonate film. All new items were directly fair draughted on the matt side of this sheet and on separate overlay sheets of the same material for each of the other colours. Drawing was done with Rotring-Foliograph reservoir ink pens. Register marks were drawn on all sheets. The guide copy was fitted to the orthophoto. New roads and other items were drawn, houses were in part added by the rub-on technique. All details to be deleted were opaqued with a red fibre-tip pen on separate overlay sheets for each colour, used as hold-out masks later on.

Independently from the orthophoto production, the same models were oriented once again for plotting contours in pencil on a matt Pokalon sheet. All new contours were traced and fair drawn in relation to the new planimetry. The hachures were produced with rub-on symbols on a separate sheet. (Fig.3)

In three of all the other test samples the orthophoto method was used as well. In Delft an interesting alternative was executed as follows at the working scale 1 : 15 000: A positive of the orthophoto was copied by diazo process onto a yellow scribe coat. By a second exposure with the negative of the remaining planimetry these elements appeared in yellow. The new items were scribed on this coat. The final colour plates were produced by combining them with the other negatives.

This very short abstract of the detailed descriptions in the final report may illustrate the great variety in concepts for map revision with which the participants in this test experimented.

Fig.3 Reproduction Diagram of the Map Revision Procedure applied by the State Survey of Baden-Württemberg in Stuttgart: Orthophoto production from 1:30 000 imagery and drawing at 1:10 000



and so on for the other plates

Fig.4 Orthophoto at the scale 1:25 000 showing the Test Area near Fribourg; Four participating Centres revised the Map with the Help of an Orthophoto at the scale 1:10 000.

Quantitative and Qualitative Results of the Test

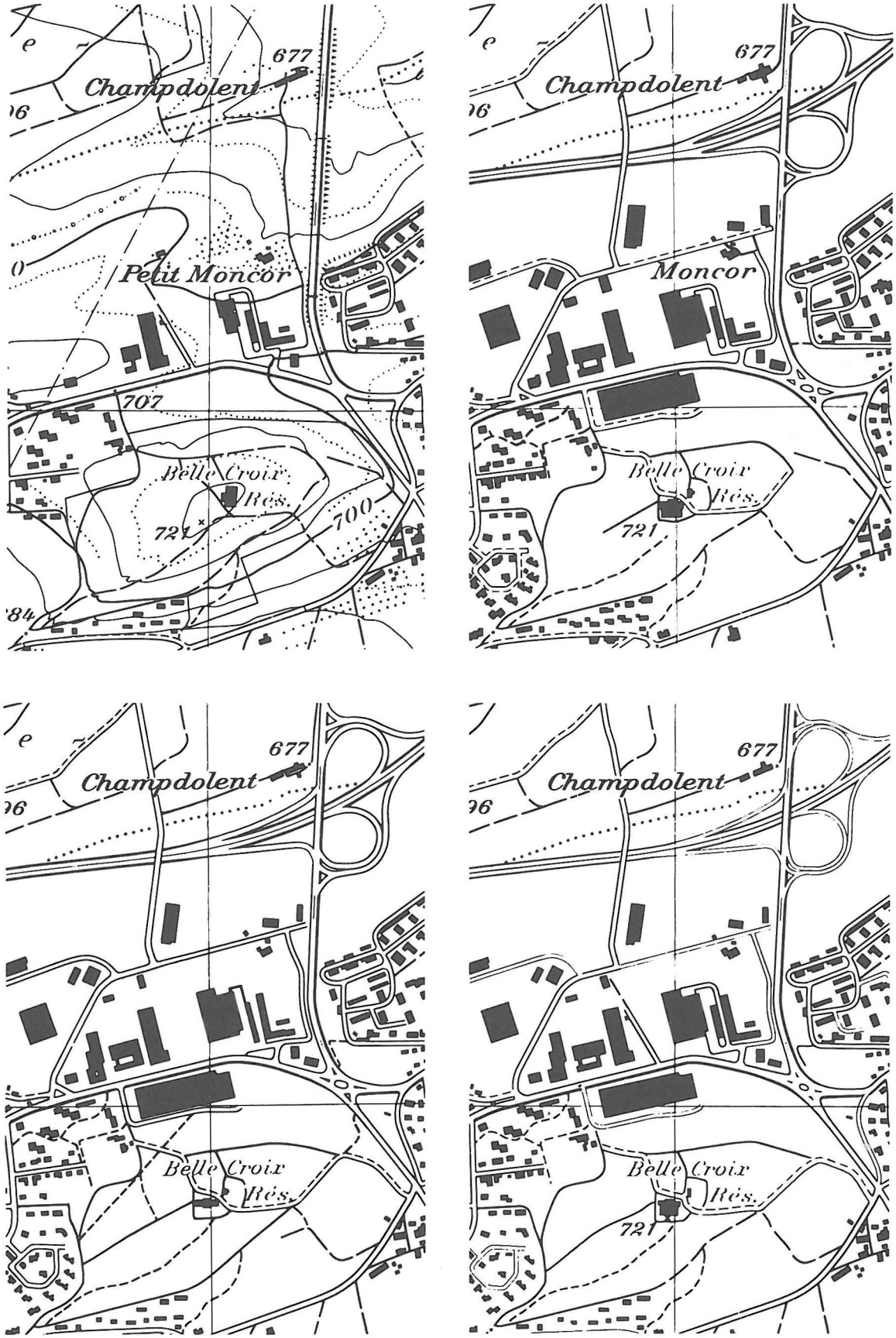
In order to assess the various mapping techniques the test samples were analysed in as much detail as possible. Five areas for map quality evaluation were distinguished, namely completeness, correctness, positional and height accuracy, line quality and generalisation problems.

One of the problems, when studying economic solutions for the map revision problem, is the amount of field identification needed to assure a high degree of completeness and correctness in the final map. Within this test a special solution had to be found for this problem. Each centre received information about the entire road network, but nothing else except on demand.

Some verification effort was therefore devoted to check the completeness of buildings in the whole test area on each individual map sample. Some 2000 houses existed already in the 1968 map of this area, 400 were constructed and 90 disappeared in the period 1968-76. The realisation of these changes was checked grid by grid, all ten restitutions in parallel. 95% of all new houses were added correctly. The few smaller ones missing are mainly situated in densly built-up areas. The same is true for the 26% of deletions that were omitted and the 25% of changes on existing buildings that were not detected. More care has obviously to be given to this aspect of change detection. As far as this analysis is representative, none of the methods used seems to offer noticeable advantages in terms of completeness, nor was the result influenced by the image scale.

The general evaluation of the form of the new houses plotted indicates that 4% of all of them do not have their characteristic shape or orientation. Some of these defects are due to different generalisation attitudes. The differences between the solutions of the individual centres will be illustrated in the final report. As figure 5 shows they may be quite considerable. The participants however felt that generalisation at 1 : 25 000 may follow different concepts, if the thresholds of visual perceptions are taken care of. The measurements of 100 sides of houses showed that between 0% and 11% of all of them were smaller than the recommended 0.2 mm. All test samples showed spacings between houses that were smaller than the minimum of 0.15 mm. A detailed analysis of small sample areas indicates that there seems to be

Fig. 5 Combined Base Map of the 1968 Edition and 3 up-dated Extracts of the Black Plate for Comparisons



too much variety between the individual solutions, that is not justified by the kind of complexity of the planimetry in this test area.

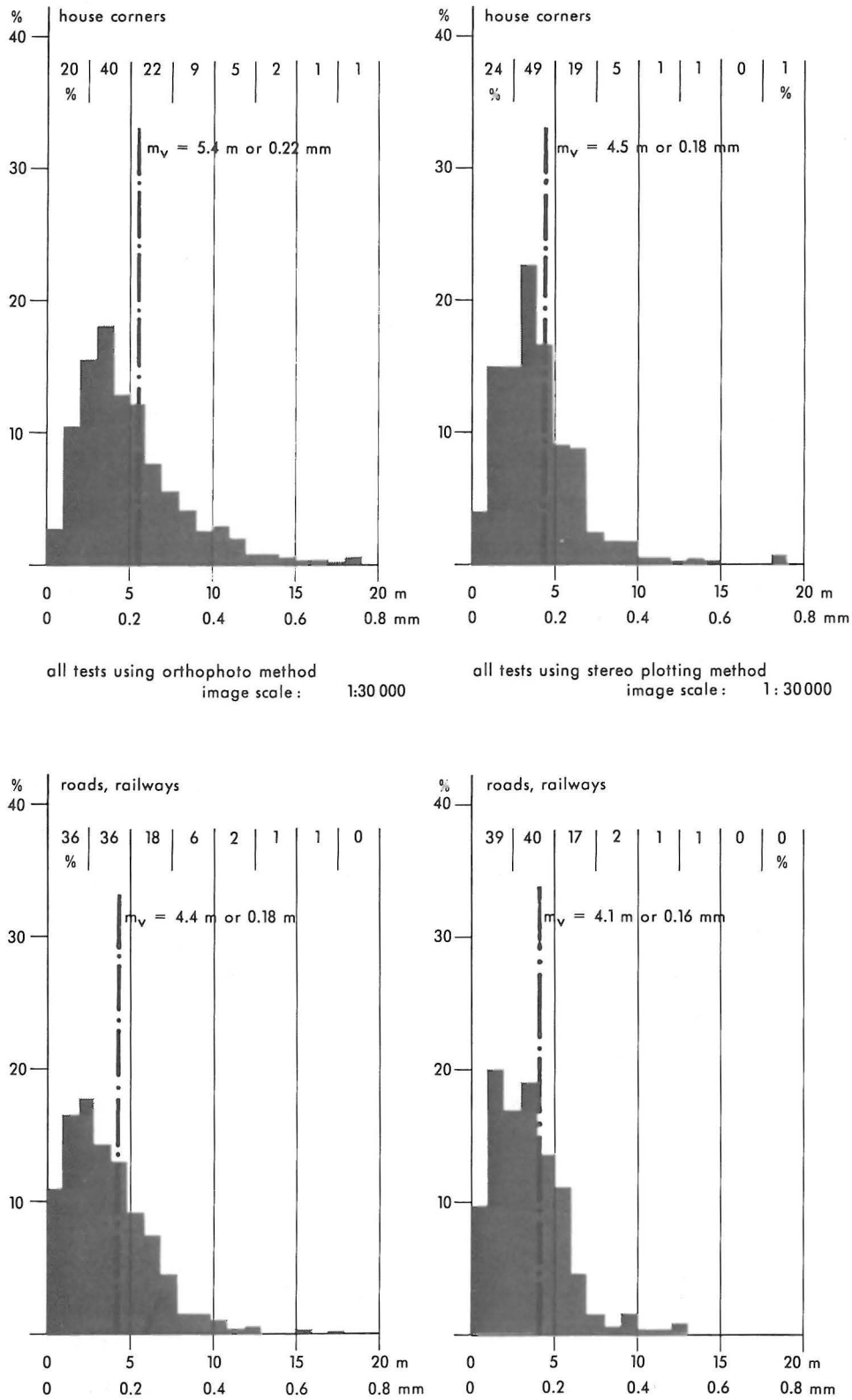
Another aspect that was evaluated was line quality. In comparison with the base map of 1968 a number of test samples showed obvious increase or decrease in line widths. They are caused mainly by consecutive reproduction processes and very critical for the life of a map series. In the 2 extremes out of the 10 final films the original line width had decreased for 0.03 mm and increased for 0.04 mm. This affects of course mainly the thin lines and the spacings between various elements.

Positional and height accuracies were checked against a large scale verification map at 1 : 25 000. The measurements of the positional errors of house corners, road axes etc. were made in the stereocomparator on the final film positives. Details about the procedure and about the results are given in extenso in the final report. The following information summarizes these findings: The planimetric accuracy of the base map that had to be revised can be characterised by a standard deviation of ± 0.15 mm or less depending on the kind of feature. Only 3% of all 177 points measured deviated more than 0.3 mm. The accuracy found for the 47 spot heights of the base map was ± 0.69 m. It can be said therefore that the base map of 1968 was accurate and homogeneous, certainly a parameter of great influence to the revision method to be chosen and to the interpretation of the test results.

As many as 372 points were measured in each of the 12 test samples to get an idea on the positional accuracies obtainable by the various methods. Error histograms were constructed for each point category and test sample. As an example table 1 gives the average distribution of the residual positional errors comparing the orthophoto (4 participants) and the stereo plotting method (3 participants) basing on the image scale 1 : 30 000. The standard deviations computed for house corners are 0.22 mm and 0.18 mm and 0.18 mm and 0.16 mm for road and railway axes. We can therefore state that the accuracies to be expected from these two methods are practically the same and satisfy the usual tolerances for this type of mapping. The more detailed analyses of the histograms shows however that there are considerable differences within each category. In the orthophoto method as well as in stereo plotting the standard deviations vary between 0.14 and 0.28 mm.

Fig.6 Summarized Results of the Assessmant of Positional Accuracy of House Corners and Road and Railway Axes; left Orthophoto Method, right Stereo Plotting

Table 1 : Distribution of residual positional errors



Another remarkable result is the fact that the image scale 1 : 18 000 gave practically the same results as 1 : 30 000 in this map revision test. The National Board of Survey in Helsinki carried out this test also with the stereo facet plotter OMI. The standard deviations obtained, 0.26 and 0.20 mm for house corners and road axes, seem surprisingly good. It has to be noted however that the range of errors is considerably larger and that 25% of all house corners deviate more than 0.3 mm from the true position. The correlation of error vectors and topography is not as obvious as might be expected.

Distributed over the whole model 40 spot heights had to be measured by each operator. The standard deviation of an individual spot height measured in images at 1 : 30 000 was ± 0.75 m or 0.16% of the flight height, the respective value received from 1 : 18 000 images was ± 0,62 m or 0.22%. The loss of accuracy, when using only spot heights of the base map for the model orientation instead of signalized points is not significant. But in this case model levelling should be based on as many map points as possible. A visual comparison will be given between the revised contour lines and those of the verification map. All map samples will be reproduced in full colours in the final report.

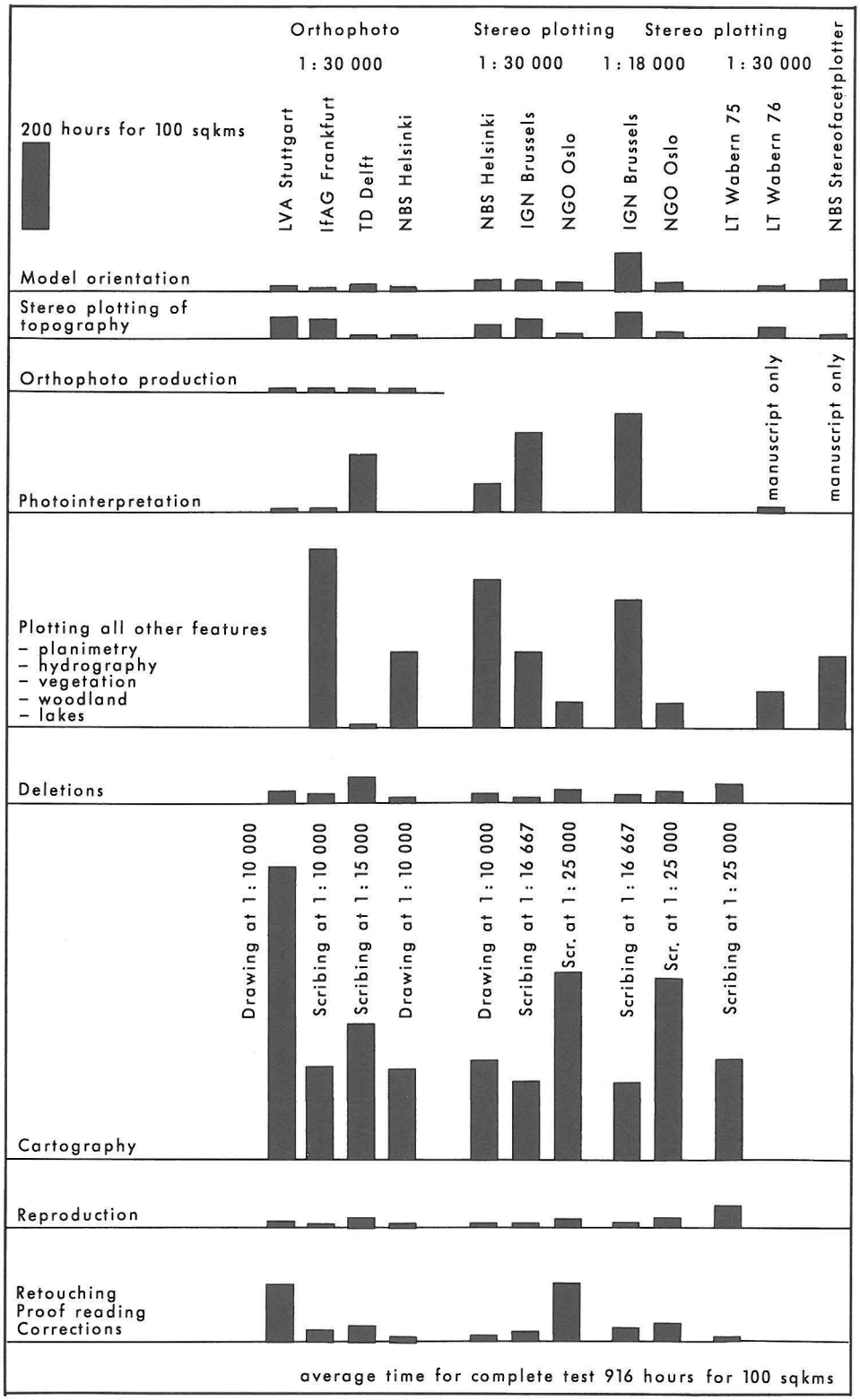
Time and Cost involved in the Revision Processes

The time needed has been registered and listed for each individual procedure, including all cartographic and reproduction work. The comparison indicates considerable differences even between similar jobs. A number of interesting facts can be drawn from these figures. Most of the time is needed for cartographic work, and much less for the photogrammetric part. The same kind of job may need in some cases only half of the time as in other ones. Besides material and instrumentation needed, the different categories of personal involved will have to be taken in account too, when speaking about cost. This part of the analysis is still going on.(Fig.7)

Conclusions

The members of Commission D of the OEEPE are satisfied with the results of this experimental research in map revision methods. This challenging task brought up quite a number of interesting ideas and gave satisfactory results

Fig.7
Time needed for each individual sub-process in the revision procedure. The hours indicated base on a unit of 100 km^2.



with scarcely any exceptions. Some problems have been revealed by this experiment, as e.g. methods for change detection, criteria for cartographic generalisation of houses etc. The final publication of the test results will give in detail more information on map revision procedures actually in use and studied in OEEPE countries.