

SURVEY DIRECTORATE

G.H.Q.

MIDDLE EAST

TECHNICAL PAMPHLET No.13

Instructions for the
Use of Slotted Template Equipment.

(These instructions are a reprint of the pamphlet

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dated 9 November 1942.)

Instructions For the Use of the

SLOTTED TEMPLATE EQUIPMENT

1. General Description.

The slotted template method is a method of carrying out the minor control, the combination of the minor control and scaling and fitting to ground control of air photo surveys mechanically.

In this method each photograph is represented by a card board 'template' in which a circular hole is punched to represent the principal point and slots radial to the principal point are punched to represent the radial lines of the minor control plot.

Metal studs of which the upright just fits the centre circular hole and the width of the slots in the template, represent the principal, the minor control, lateral control and intersected points.

In a single strip, the templates are assembled with a stud passing through the principal point of each photograph and also through the slots of each adjacent photograph's principal point base slot. A stud representing each Minor control point passes through the three radial line slots to that minor control point. Assembled in this way, the strip of templates can be extended or compressed in length like a concertina, the minor control studs moving outwards as the strip extends.

If a stud representing a ground control point is fixed on the plot to the correct position of the point and the slots to the photo point on the templates placed over it, the strip of templates can be swung around this fixed point and pulling in and out radially from it. The strip can, therefore, be placed so that slots to a second fixed point can be dropped over a stud fixed in its correct plotted position and the strip of templates is then permanently fixed.

Adjacent strips are assembled and fitted to studs representing lateral control points, intersected in the first strip. In this way, whole areas can be built up.

Each metal stud has a hole drilled vertically down the centre into which a stout pin just fits. When a complete area has been assembled the positions of the principal points, minor and lateral control points are fixed on the plot by nailing pins through the centres of these studs. The templates can then be taken up, the points numbered, the pins and studs removed and the section prepared and Survey carried out in the usual way.

2. Apparatus.

(a) The apparatus consists of:-

- (I) Bristol board cards of suitable size for templates.
- (ii) Prickers for pricking points on to the templates.
- (iii) Clip boards of stout straw board to hold the photograph and template whilst pricking.
- (iv) End grain wood block to support the template for centre punching.
- (v) Centre punch and hammer for punching the template principal point.

(vi) Slotting machine.

(vii) Assembly boards

(viii) Metal studs, and (ix) Special nailing pins.

(x) For large assemblies, sponge rubber mats are required for moving about over the assembly without disturbing the studs and pins.

(b) Templates, should be of 4-ply Bristol board one inch each way larger than the effective area of the photograph but in any case not less than 7 inches x 7 inches.

(c) Prickers. The pricker should carry a fine needle (not larger than No.12) for pricking through the photograph to avoid damage to the photograph. The hole in the template may, if desired, be enlarged with a No.6 needle for ease in slotting.

(d) Clip-Board. The clip-board should be the size of the template and have a loose "bull-dog" clip to grip the photograph and template securely. The board must be of straw board and not of wood in which the grain will deflect the point when pricking. In place of the clip board, a sheet of straw board may be used as a support and the photograph may be attached to the template with adhesive tape or fixed down with drawing pins.

(e) The Wood Block may be of any medium or soft wood cut across the grain.

(f) Slotting Machine. The machine supplied cuts a slot $2\frac{1}{2}$ inches long and $1/8$ inch wide, from $1\frac{1}{2}$ inches inside to 1 inch beyond the point. It will cut slots to within $\frac{1}{8}$ inch of the centre. The use and maintenance of the machine are dealt with in paras 8 and 14 respectively but the dimensions above must be borne in mind in the earlier stages of preparation of the templates.

(g) The sponge rubber mats should be 2'6" x 2'0" x 3" or larger.

3. Preliminary work.

(a) The approximate scale of photographs is worked out and the plotting scale is selected. In this connection it must be remembered that the method permits of assembly of the templates on a scale considerably different from that of the photographs but that the inconvenience of surveying detail on a section differing in scale from the photographs will still exist. The plotting scale should therefore be a round scale conveniently close to that of the photographs in the area of greatest detail.

(b) All the existing ground control is marked up on the strip index of photography and the photographs containing control points examined. The control points should be identified independently by two men and those regarding which there is no doubt should be distinguished on the index and the photo numbers entered against them.

(c) From the index thus prepared the best controlled strip is selected as the first strip to be laid down. It is an advantage if this strip has two control points fairly close together to serve as a starting point.

- (d) When handling small photographs, say 7 x 7 inches or smaller those pairs in the overlap of which two or more ground control points fall should have their positions fixed on the plot by means of separate kodatrace hand-drawn templates.
- (e) To prepare these templates, the principal points of the photographs are pricked and mutually transferred. All ground control points (including those on the photographs but outside the overlap in question) are pricked and numbered on the photographs. For each photograph a kodatrace tracing of the principal point, the principal point base and the radial lines to the ground control points is made. These tracings or kodatrace templates are re-ected into position as soon as the assembly board is plotted (see para 9) and when final positions are decided the principal points are pricked through. These fixings for the principal points will thereafter be used instead of the ground control point plottings for that particular strip. This procedure will save much time and trouble from misidentified points and from slots in the slotted templates clashing. Once this preliminary work is completed the processes of preparing photographs, pricking and slotting templates and plotting the assembly board can proceed simultaneously.

4. Preparation of the Photographs.

- (a) All ground control points are marked on the photographs.
- (b) The principal points of all photographs are marked and transferred to adjacent photographs.
- (c) Lateral control points common to the adjacent strip should next be selected and marked. One is required per photograph on the strip. Where possible they should be situated so that they will serve also as minor control points (that is appear on three photographs in the strip). Where this is not possible they must be at least half an inch in the direction of the strip from the location for the minor control points.
- (d) Minor control points are selected, marked and transferred to adjacent photographs.
- (e) The photographs are now checked against the index map to ensure that all ground control has been marked on the photographs. The photographs are then checked to ensure that all ground control points and lateral control points have been clearly marked on all photographs in which they appear. This is most important as templates have to be scrapped if they are incomplete when punching is begun.

5. Pricking the Templates.

One of the Bristol board templates (para 2(b) above) which have been spread out in the plotting room to season for a few hours, is taken and positioned below a photograph so that if possible no points pricked on the photograph fall within $1\frac{1}{4}$ inches of the edge of the template. The photograph and template are clipped to the board (para 2(d) above) and the loose clip attached to hold both securely.

Each of the points on the photograph is pricked through the photograph on to the template so that the prick just appears on the back of the template. This should be done methodically to avoid missing any points, thus: minor control points first counting nine points in all; then lateral control points at least four and possibly six; then ground control points.

The first point pricked is re-pricked and the bulldog clip removed and this point examined. If two prick marks appear on the template the photograph has moved and the points must be pricked on to a fresh template.

All the points pricked are circled in black pencil on the template and the number of the photograph is written against the principal point on the template so that it reads correctly when oriented with north away from the reader.

The template is removed and the ground control and lateral control points are numbered clear of the radial lines.

The pricks are numbered with lettering 1/8 inch high close to the point, on the radial strip which will be punched out by the slotting machine. The number of the photograph appears first followed by the number of the control point or the letter of the minor control point.

6. Radial Lining.

When a strip of templates is pricked it is examined for points requiring adjusting before slot punching. Before a slot can be punched for a point falling within two inches of the centre a radial line must be drawn through the point to a distance of at least $2\frac{1}{4}$ inches from the centre. This may be done with a straight edge and hard pencil.

If two points fall in such a position that the radial slots of $2\frac{1}{2}$ inches long by 1/8 inch wide will overlap they can usually be adjusted as follows:-

- (a) The two points will normally be a minor control point and a ground control point. If their radial distances are nearly the same the ground control point will probably serve as a minor control point and the other should be deleted.
- (b) If their radial distances are sufficiently different one slot may be displaced inwards and the other outwards to accommodate both. In this case proceed as follows. Roughly mark the circumference of a circle centred on the principal point falling midway between the points. On the radial line to the nearer point mark the point $1\frac{1}{8}$ inches nearer than the mark half way between the points, or the point 2 inches from the principal point whichever is more distant. On the radial line to the further point mark the point $2\frac{1}{2}$ inches further from the centre than the point just marked.

7. Centre Punching.

Before punching the centres the templates must be examined by the section officer to see that all points are pricked as in para 4(e) above. When the templates are passed as complete, each one is taken and placed on the supporting block (para 2(c) above). The centre punch is taken in the left hand, the centre pin placed in the principal point prick and the punch pressed down vertically until the punch is resting firmly on the card. The punch is then given a sharp blow with the hammer just sufficient to cut the card cleanly.

8. Slotting.

After centre punching, the template is placed in the slotting machine with the centre hole on the centre stud (A) of the machine. The template is swung round and the centre

stud slid forward until the registering pin is over the prick. The lever arm is pulled slowly down until the pin enters the hole when the slotting is completed, with a sharp pull down. The fingers should hold the card down at the near end of the blade as the lever is allowed to rise, particularly when punching close to the centre of the template. It is advisable to work the slotting machine with the master eye as nearly in line with the blade as possible, i.e. if the left is the operator's master eye the operator should be on the right of the machine with the left eye close under and to the right of the lever arm. The lever will in this case be operated by the left hand and the template positioned by the right hand. The operator should examine the punchings periodically and all must be retained. The section officer should examine and count all punchings to see that slot cutting is accurate. The punchings are easily and rapidly examined by turning them upside down. The original prick is visible and it is at once evident whether it is central on the punched strip. Those which are not central are turned over and the photo number and point recorded and if necessary a new template is cut.

9. The Assembly Board may be heavy straw board, zinc sheets or pressed fibre board. Wood should not be used on account of the deflection caused by the grain when nailing. If the area required is larger than the standard sheet size, sections should be joined together by adhesive tape. For areas up to 8 feet by 6 feet the grid may be constructed on the assembly board by the usual drawing office methods, the central 8 foot line being drawn by means of two 4 ft straight edges made collinear with a third 4 ft straight edge and three rectangles of diagonals of less than 48 inches being constructed on each side.

For larger areas the grid should be laid down by the Fairchild method described in para 13 below.

Plotting of control is carried out normally after the drawing of the grid. When working on zinc the grid is scratched on the metal and points are marked by fine crosses.

After plotting metal studs are fixed to all control points. This may be done by nailing or by sticking the stud down. The latter is much the more convenient method. A stud is placed on one of the special pins and the base of the stud covered with a suitable adhesive (Seccotine or Durofix). Holding the stud well up the pin, the point of the pin is placed on the control point and with the pin vertical the stud is pressed firmly down and the pin removed.

10. Assembling.

The templates of the strip selected as starting strip (para 3(c)) are taken and the template containing two control points, or that containing one of the two nearest together is laid down. Metal studs are inserted in the principal point and in each slot except that to the control point which is engaged on the control stud stuck to the plot. The template next towards the nearest control point is placed in position so that the stud in the slot towards its principal point engages in its principal point. The other studs are slid along until they enter the appropriate slots of the new template. More studs are inserted in the empty slots of this template. Assuming the strip is being laid to the east with the operator looking north the next template is laid thus:-

Take the template so that the photo number reads correctly, trim round the edges close in to the ends of the slots but without cutting them open. Holding the template with both hands bend it slightly downwards in the middle and engage its principal point over the stud already loose in the slot of the last template. Keeping the template bent turn it until the slot to the previous principal point is over that stud then slide the template and its stud to the right or left until the left hand minor control slots are over their studs. Lower the left edge so that the three studs engage in their slots. With the left hand, now free, slide the studs, still free in single slots, representing the minor control points abreast the principal point, in or out until they engage in the slots of the template being handled and lower this template down engaging any ground control or lateral control studs at the same time in their appropriate slots.

This latter operation must be done gently. It presents most difficulty when the second ground control point is met, that is when the strip is as yet unscaled. If the slot falls short of the fixed stud, gently pull the last principal point stud outwards with one hand, tapping the previous templates with the other or gently pushing pairs or minor control studs apart with the span of the hand. The fewer the studs the easier this operation is. It is for this reason that the assembly is started between the nearest pair of control points. For the same reason, the studs representing the lateral control points if other than the minor control points should be omitted until the scale in the first strip is established. When the second control point is engaged in its two slots, these lateral control studs can be inserted by lifting and slightly bending the edges of the templates.

It may be necessary in a long stretch to get approximate scale by using the minor control points on one side of the base only and then relaying with all studs in.

Once one strip is down, the adjacent strip can easily be assembled since the lateral control points provide the scale. If difficulty is experienced in fitting templates to lateral control and minor control points slight bowing of the first strip may help but no force must be used and if the template will not go down easily it should be omitted, the section officers attention drawn to the fact and the area worked round by the next strip.

11. Preparation of Survey Sections.

When the whole area has been satisfactorily assembled, the studs are nailed down. Studs well spaced between ground control are first nailed down with the special pins (on metal their positions can merely be pricked and care in dismantling and numbering is necessary) and then all intermediate studs. The templates are then taken off and as each stud is uncovered it is ringed, numbered and unpinning.

When the whole is dismantled, the usual kodatrace sections with the grid drawn are placed over the assembly board and the points pricked through. Since the pin holes in the assembly board are rather large although their centres are accurately placed considerable care is required in pricking up the exact centres on to the kodatrace sections.

12. Examination of ill-fitting Templates.

The majority of errors are due to misidentified points or bad slot cutting. The case of a doubtful template should be examined as follows:-

- (a) Examine the identity of minor control points on the photographs for three overlaps on each side.
- (b) Examine the identity of the lateral control points for three photographs on each side on each strip.
- (c) Examine the transference of principal points for three overlaps.
- (d) Place the doubtful template over its photograph with the principal point centrally in the punched hole and correctly oriented and see whether all other points are central in their slots. If the slot punchings have been carefully examined this is a test of the principal point punching only.
- (e) If no errors are found work round the area omitting the faulty photograph and reset it in afterwards.
- (f) If the area cannot be worked round owing to repetition of these errors and there are more than two ground control points in use, see if the error is due to a faulty control point by releasing the suspected stud from the plot (by unnailling or ungumming the stud).
- (g) If no remedy is found, but there is evidence of considerable tilt combined with very great height relief, the attempt to set up the whole area should be abandoned, pairs of adjacent strips with least tilt should be assembled with minor control and principal points as near one height plane as possible. These strips should be nailed down and the intermediate templates fitted in placing them under strain if necessary.

13. The Gridding of Large Assembly Boards.

The following is the method of plotting large areas described by Fairchild Aerial Surveys. The theodolites used in the method must have their trunnion axes quite level and this must be checked before work is commenced in the appropriate manner.

The latest method, and by far the most accurate to date was devised by W. Whisenand. A summary of it follows:

- (1) Set up theodolite No.1 as close as possible to the end of the proposed central construction line, as low as convenient.
- (2) Level carefully, and check adjustment by plunging the theodolite several times on a point at the far end of the construction line, on opposite faces.
- (3) When the instrument is in perfect adjustment set a series of points about three feet apart down the central construction line. This is done by locking the horizontal plate and sighting down the board at three foot intervals, and moving a fine needle into the point where the cross-hairs intersect the board.

- (4) Theodolite No.2 is next set up as closely as possible to the position of one of the perpendicular construction lines, and adjusted by plunging in the same manner as was theodolite No.1
- (5) When theodolite No.2 is perfectly adjusted, set cross-hairs of theodolite No.1 on the far end of the central construction line. Set horizontal vernier to zero and turn off angle until theodolite No.1 is sighting on the axis of vertical rotation of theodolite No.2, and the cross-hairs of the two instruments may be now brought into coincidence by sighting theodolite No.2 into theodolite No.1. It is very important that for this step each telescope be focused at infinity. This may be done by focusing both on a distant object, or by focusing only one on a distant object, and then making the stadia hairs on the other coincide. Set Horizontal vernier of theodolite No.2 to zero. Read angle on theodolite No.1, and then turn theodolite No.2 to the complement of this angle. Lock theodolite No.2 and set points along construction line. This procedure will make the angle at the intersection lines a true 90° angle and will insure that all construction lines are straight. This same procedure may be repeated for as many other parallel construction lines as are necessary, merely change the location of theodolite No.2
- (6) A final beam compass check is made before plotting begins. This is done by setting off equal distances on the central and parallel construction lines, and checking across the diagonals.
- (7) When the two bases are constructed accurately the projection can proceed normally.

14. General Maintenance Instructions for the Fairchild Slot Cutter

- (a) The instrument now contains the No.1 punch and die assembly. It has been sharpened and adjusted. The punch will cut about 12,000 slots before sharpening is necessary.
- (b) To sharpen punch, remove it from plunger, and grind down three thousandths inch.
- (c) To re-adjust remove side plate from plunger. Fix punch to plunger with dowel pin and set screws. Insert Punch in plunger, remove operating handle, and set punch in die. Attach side plate to plunger with four adjusting screws loose. Cinch up on four adjusting screws until plunger moves with some difficulty. Set lock nuts on adjusting screws, and attach handle.
- (d) With the instrument is a spare set of dies and punch. If it proves necessary to use this second set, it can be adjusted **ONLY IF PUNCH DOWL PIN AND END SET SCREW IS LEFT OFF**. This second set of punch and dies should be used only in emergency and is not intended to be a standard spare.
- (e) Extra centering pins and springs are supplied for the punch. If instrument is well cared for, lubricated, etc., each centering pin should last for some 25,000 cuts.
- (f) Extra photo center buttons are supplied. The instrument should be checked periodically to assure that slot cuts are truly radial from this button.