1 : 50000 Mapping in Canada

A comment on the comparison of the computer programs PAT-M 43 and SPACE-M*)

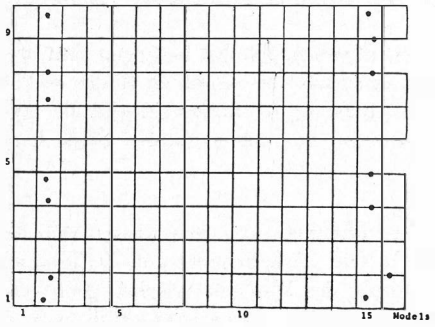
by H. Ebner, Stuttgart

The paper "1:50000 Mapping in Canada", published by M. E. H. Young in BuL 6/1973 includes a comparison of two computer programs for block adjustment by independent models. The system PAT-M 43, developed at the Institut of Photogrammetry in Stuttgart and used by the Canadian Department of Energy, Mines and Resources (EMR) since 1972 is based on a planimetry-height-iteration. The SPACE-M program, written by J. A. R. Blais at the EMR (first version finished 1973) determines the 7 transformation parameters of the individual models together. Both systems are using a direct procedure for the solution of the reduced normal equations.

The comparison of the two programs, as presented in the article mentioned, concerns the height accuracy of adjusted block points and the computing time for the three dimensional block adjustment. The main claims were:

— As long as standard control distributions are used the two systems give practically identical height accuracy (Fig. 3 of the original paper). In case of very poor height control, however, the SPACE-M accuracy is significantly superior to the accuracy obtained by PAT-M 43 (Fig. 5 of the original paper, repeated below).

— Both programs need the same CP time approximately (Table 1 of the original paper, partly repeated below).



Scale 1 : 27.500
Vertical Check Point Residuals

	RMS Ground	CP time
SPACE M	5.27 m[1])	326 sec
PAT M 43	7.04 m	338 sec

Control points 14
Check points 362

Those results are in disagreement with theoretical expectations:

— Concerning height accuracy both systems should be rather equivalent, even in case of poor control.

— Due to the planimetry-height-iteration PAT-M 43 should require significantly less CP time than SPACE-M.

The author had the opportunity to clarify the issue, during a stay at EMR in Ottawa in March of this year. A number of additional adjustments, using both programs, were performed by J. A. R. Blais, using the CDC 6400 computer of EMR. The author is grateful to the EMR for making the computer running time available and to J. A. R. Blais for his cooperation.

First it was found that the original comparisons of PAT-M 43 and SPACE-M were based on different weight assumptions. The second difference found refers to the number of iteration steps: With PAT-M 43 3 planimetry-height-iteration steps were performed, but only 1 spatial iteration step was applied with SPACE-M.

*) cf. BuL 6/1973
1) In the original paper 1.75 m is printed instead of 5.27 m. This error was announced already in BuL 3/1974.

To allow for a comparison[2]) of the two programs under equivalent conditions the block adjustments were repeated, applying 2 full iteration steps each and using the same weights:

weight 1 for all photogrammetric model coordinates
weight 0.2, 0.2, 1 for the x, y, z coordinates of perspective centres
weight infinite for the geodetic control point coordinates (errorfree control).

For the example, represented in the figure above the new accuracy results (RMS values of vertical check point residuals) and the corresponding computing (CP and IO) times are:

		RMS	CP	IO
PAT-M 43	after 1st iteration	6.23 m		
	after 2nd iteration	5.69 m	245 sec	660 sec
SPACE-M	after 1st iteration	6.21 m		
	after 2nd iteration	6.59 m	518 sec	2926 sec.

The height accuracy obtained with PAT-M 43 is here better than the SPACE-M accuracy. But two other adjustments, using similar poor control distributions in height gave a slight superiority for SPACE-M. Further on the results confirm that both programs need a second iteration step. A third step changes the results at mm only. Concerning computer running time we see that PAT-M 43 is faster than SPACE-M: In CP at a factor 2 and in IO at a factor 4 approximately.

Summarizing these results it can be stated:

1) The relatively large influence of the weights over the final results demonstrate very clearly the weakness of blocks with poor height control. In practice control distributions as investigated here have to be avoided and are avoided usually.
2) In case equivalent weights are used PAT-M 43 and SPACE-M give the same level of accuracy, even when poor control distributions are used in height.
3) The convergency properties of PAT-M and SPACE-M are similar. As a consequence both programs normally require the same number of iteration steps.
   This statement was confirmed recently by the adjustment of an artificial test block simulating mountainous terrain and poor initial values of the transformation parameters.
4) As a result of the time saving planimetry-height iteration PAT-M 43 is significantly faster than SPACE-M. This is true for CP and in particular for IO.

[2]) Further comparisons are planned by J. A. R. Blais, including mountainous terrain also.