

REPORT ON THE EVOLUTION OF THE ORTHOPHOTO EQUIPMENT  
AND THE  
ORTHOPHOTO PRODUCTION PROCESS IN THE PERIOD  
1976 - 1980  
(invited paper)

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ABSTRACT

This report gives the results of an investigation on the evolution of the orthophoto equipment and the orthophoto production process in the period 1976-1980.

The report is based on the answers to a questionnaire obtained from manufacturers of orthophoto equipment and from important institutions and offices concerned with orthophoto production.

RESUME

Ce rapport résume les résultats d'une enquête concernant l'évolution des équipements orthophotographiques ainsi que celle de la production d'orthophotographies dans la période 1976-1980.

Le rapport est basé sur réponses à un questionnaire reçues des constructeurs d'équipements ainsi que des institutions productrices d'orthophotographies.

ZUSAMMENFASSUNG

Dieser Bericht bringt die Ergebnisse einer Untersuchung über die Entwicklung von Orthophotogeräten und Orthophotoproduktion in der Zeit von 1976-1980.

Der Bericht is basiert auf Antworten von Herstellern von Geräten und Institutionen und Dienststellen die sich mit der Orthophotoproduktion befassen.

## 1. INTRODUCTION

This investigation was organized by commission II of the I.S.P. in order to collect information on the evolution of the orthophoto technique, the orthophoto equipment and the evolution of the orthophoto systems in the future. The report does not address the practical use of orthophotos.

The questionnaire contains two parts :

Part I : addressed to the manufacturers of orthophoto equipment.

Part II : addressed to the institutions and offices concerned with the orthophoto production process.

This report gives the results of the investigation. Part I was sent to 9 manufacturers or institutes involved in research in the orthophoto technique and instrumental development. The questionnaire was answered by 8 of them.

Part II was sent to 50 institutions involved in orthophoto production. The questionnaire was answered by 26 of them.

The support I received was important and the answers give a largely significant statistic sample. From the collected information it comes out some results of a general character and we shall try to point out the most significant aspects.

The author refrained in this report from any exposition of his own point of view. The response by most of my colleagues was very favorable and prompt for which I wish to express my appreciation and thanks.

## 2. QUESTIONNAIRE ADRESSED TO THE MANUFACTURERS OF ORTHOPHOTO EQUIPMENT. (Part I)

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21. After several years of investigations in the orthophoto technique do you think now that the manufacturing of orthophoto equipment must be continued ?

The answer is undoubtedly : YES. The orthophotography is an important product of the photogrammetric technique and it will play an increasingly important role in mapping operations. Orthophotography and orthophoto mapping have established themselves as practical economic processes suitable for a wide range of uses. A potential market still exists for this equipment.

22. If you estimate that manufacturing must be continued what is your opinion about the orientation of the activities in the future :

- construction of the existing equipment without modifications.
- construction of the existing equipment with modifications in order to improve the performance.
- construction orientated on a new conception of the orthophoto technique.

It appears from the answers that manufacturing will be oriented to the construction of existing equipment with modifications in order to improve the performance and to reduce production time.

It seems that construction is oriented to :

- systems in which an orthophoto may be produced from a single dispositive, using the input of digitized data from remote stereo-plotters.
- A modified slope control
- New computer functions within the system converting the profile scanning to a D.T.M.
- A digital image transfer (in the long run).
- A real time computer control of the process.

23. If you are considering modifications or the application of new principles how far have you got :

- stage of principles
- stage of a precise theoretical examination
- stage of practical application
- stage of manufacturing in the near future.

This question was too direct. We can understand that some manufacturers declined to answer this question for reasons of commercial secrecy and prefer to postpone the answer until the congress is over.

24. Have you received interesting proposals of your customers in order to improve or facilitate the production of orthophotos with your equipment.

The answer is undoubtedly : NO

Almost all suggestions from users have been found too impractical. The improvements which have been made have mostly originated in-house. The customers seem to be satisfied with the variety of options that are currently available.

25. Do you think that manufacturing must be oriented on "universal" orthoprojectors covering the needs of all users of orthophotos or do you prefer more restricted equipments adapted to more specific applications.

The answers reveal two tendencies :

Universal equipment (4/8)

In many cases the orthophotos are produced centrally and will serve a wide range of applications. Universal orthophoto production systems will therefore be needed.

The orthoprojector must be "universal" but the data-acquisition must be specific and adapted to each type of application.

Specific equipment (2/8)

The cost of the equipment should be taken into account and kept within reasonable limits. The user needs a more restrictive equipment adapted to more specific applications.

One of the answers points out that digital techniques offer better opportunities to universality.

26. Do you think that a technological development directed on a higher degree of automation is desirable.

The answer is undoubtedly : YES.

A distinction is to be made between automation in data acquisition and production of orthophotos. It seems that a higher degree of automation is desirable in the first case but that a higher degree in the production process is not necessary.

One of the manufacturers thinks that development must be directed towards a total automation but such developments would have to be cost-effective.

27. From your point of view which is the most flexible method to obtain altimetric information in case of orthophoto technique.

Several opinions must be pointed out :

1. Digital height data acquisition during model scanning. This seems to be the most economic method (time, cost) but it is still not practical to derive "good" contours economically from such data.
2. DTM grid measurements on an analytical plotter.
3. Off-line generation of digital height data in the form of contours.
4. Digitizing contours in an existing map.

28. Are you of the opinion that the automatic correlation technique is required in the future.

Six of the eight answers are positive and it is expected that automated correlation techniques will be increasingly used in orthophoto production processes.

The application of the correlation technique will depend upon the cost/benefit ratio and upon the efficiency of correlation in difficult circumstances (large scale, areas with little detail). The cost of the equipment seems to be an obstacle and should be kept within reasonable limits.

In one case the development of the correlation technique has been stopped temporarily.

One of the manufacturers has the opinion that correlation techniques are not workable for map scales larger than 1 : 7000 because the orthophoto is distorted significantly.

29. What is in your opinion the optimal relation between the scale of the stereopair and the orthophoto scale in the projector.

From the point of view of the manufacturer the ratio 1/1 is the most easy to realise from the point of view of the user an enlargement ratio of between 2 X and 4 X is the most common; for special purposes an enlargement of 6 X is possible in the case of normal-angle photography. The optimal relation depends on the resolution of the original negative and the losses of the orthophotodevice.

2IO. Are you of the opinion that remote sensing by satellites will have an impact on the development of orthophoto technique.

The majority of the answers is hopefully YES but some restrictions must be made :

- Small scales involved may make orthophotos impractical except for special uses.
- Orthophotography is not possible with the present techniques used.
- The existing equipment must be adapted.
- The resolution and cost of satellite techniques will not be able to compete with photography from low level aircraft.

2II. Do you have other informations or ideas that could improve the quality of the invited paper.

It is highly desirable to draw special attention to the imperative need for photography quality control at every stage from the original negative to the final product.

3. QUESTIONNAIRE ADRESSED TO THE INSTITUTIONS AND OFFICES CONCERNED WITH THE ORTHOPHOTO PRODUCTION PROCESS.

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3I. For your institute in particular what do you think about productiveness and redemption of the equipment you use.

This question has a very individually character. The answer depends on the particular system adopted and the specific mission of the institutes and offices. Some of them are engaged in a systematic cartographic process, others use the orthophototechnique to cover special needs. From the collected information some ideas can be derived :

- Most of the institutes are satisfied with the orthophoto equipment. Only a few of them are not pleased with it.
- The amortization of the equipment is only then good if the production of several hundred of orthophotos a year is ensured.
- The on-line principle is rather expensive on a low or middle production.

32. Are you satisfied with the orthophoto product from the point of view of both quality and metric value.

The majority of answers were : YES.

The main problems arise in compiling map sheets rather than in the production of orthophoto negatives. In a number of cases it seems difficult to produce photos without scan lines and density variation.

33. What is your idea about the evolution of the orthophoto equipment with a view to produce improvements.

Do you think that a technological development directed on a higher degree of automation is desirable.

Several proposals about the evolution of the equipment have been made.

The most characteristic ideas are :

- All future generations of orthophoto equipment must incorporate some form of slope correction device.
- In larger organisations there will be a tendency to prefer the "3rd camera" type operated on an "off-line" basis.
- Higher rates for workable values of lateral and longitudinal tilt are necessary.
- Installation of a light measuring device can improve the equality of the produces orthophotos and can eliminate testoperations.
- The scanning area can be minimized by introducing a Y-step switch.
- Introduction of numerical relative orientation can improve the production.
- A computer driven optical projection has to be developed in the future.
- Further development lies primarily in the development of more sophisticated software rather than development of new machines.
- In the future the aerial camera technique will probably evolve towards linear array technique, and the orthophoto equipment has to be adapted.

The second part of the question shows that development should be directed towards a higher degree of automation only if the production reaches a certain level.

34. Can you make out a classification of the manufactured documents according to the scale.

It is very difficult to give an average of the percentages on account of the extreme values for each scale. However an approximate classification according to production scales would be as follows :

- very large scales (1 : 1000; 1/2000) : 20 %
- large scales (1 : 5000 to 1 : 10000) : 50 %
- medium scales (1 : 20000 to 1 : 50000) : 27 %
- small scales (1 : 100.000) : 3 %

The answers deal with a very large amount of situations in different countries. We must point out that in the generality of the cases, except some countries, there is not a well defined policy for the systematic use of orthophotos in cartography. In many cases the orthophoto is used to cover special needs only.

35. How did you solve the problem of altimetric information.

- In 80 % of the cases the contours are plotted using conventional photogrammetric methods and usually on a completely separate instrument from orthophoto production. The contours are overprinted on the final orthophotograph.
- In some cases digital information is simultaneously recorded during contouring and the generation of profiles is made by computer for off line digital orthophoto scanning.
- A small scales altimetric information is registered along the scan lines and contour lines are interpolated by a computer.
- Another method consists in digitising contour lines from existing maps.
- In few cases three-dimensional data is registered in the form of a network of digital information (DTM).
- The "drop line" method is not very common because it seems to be inaccurate and it increases orthophoto scanning time.

36. Do you think that the rather high prices of orthophotos represent an important obstacle to their diffusion.

For 70 % of the orthophoto producers the answer is unquestionably : YES



The other 30 % of them cannot agree with the implication that the price of orthophotos is rather high because orthophotomaps generally cost about 20 % less than the equivalent line maps.

37. Do you see a possibility to reduce the price of orthophotos.

It seems to be difficult, in the present circumstances, to reduce the price. The following ideas are advanced :

- Produce a bigger volume by co-operative systems.
- Publish the product in photographic overlap format instead of compiling into standard map sheets whenever possible. When several orthophoto negatives have to be compiled into one sheet, tonal differences and minor discontinuities are apparent. Too much time is spent in trying to eliminate some of these effects. By tolerating such defects the customer will get a cheaper product.
- Cost reduction must come from introducing reasonably priced automated equipment.
- Simultaneous digitisation when plotting contour lines; once a digital elevation base is available; profiles can be generated without manual scanning and the price of orthophotographs will be reduced, install DTM
- Technical improvements in the efficiency of the cartographic stages of orthophotomap production. Enlargements must be avoided. Reduce steps in copying process.

But the most important answer on this question seems to be : educate users to tolerate blemishes and tonal differences, increasing acceptance of the orthophotomap as a good product. User education is essential for the quick acceptance of orthophotographs.

38. Are you of the opinion that the automatic correlation is necessary.

In 80 % of the cases the answers are : NO.

Automated correlation can only be accepted when automated compilation and tone matching can also be achieved.

39. Are you satisfied with the technical assistance after sale.

Yes : 70 %;                      Not completely : 20 %;                      No : 10 %;

In a few offices institute personnel has been trained to assure technical assistance in order to avoid an expensive servicing.

3IO. Have you made any proposals to your manufacturer in order to improve or to facilitate the production of orthophotos.

A very small number of institutions have made suggestions to their manufacturer. One of them concerns electronic connection of different stereo models. An other institution made proposals to the instrument manufacturer involving the redesign and strengthening of weak components, revised positions for the instrument controls to facilitate operating and revisions to the operational procedures which would allow more efficient setting-up of the equipment prior to scanning.

3II. Do you think that remote sensing by satellites will have an impact on the development of the orthophoto technique.

Yes : 50 % ;            No : 25 % ;            No opinion : 25 % ;

Orthophotos must be considered as basic support for better uses of satellite images.

#### 4. CONCLUSION

I would like to distinguish orthophotos employed to make photomaps and orthophotos just employed for special needs. For the first mode there is no doubt that it can give advantage in time but not automatically in money. For the second mode it seems that the technique is expensive and that the rather high prices of orthophotos present an important obstacle to their diffusion.

I hope that the manufacturers will find a solution in order to reduce the price and that the users of orthophotos will tolerate small blemishes and tonal differences.