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EXPERIMENTS IN PHOTOGRAPHING OLD GLOBES

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Anyone involved in research into antique globes will realise the difficulties arising from an attempt to make an accurate comparison between them. Apart from the fact that only very few specimens have been preserved which are scattered throughout the world in various collections, the three-dimensionaol spherical shape of the globe adds to the problem of how it can be classified exactly. Gores are best suited for scientific cartographical comparisons.

Taking this statement as a starting point, we in Vienna have been considering how the original flat gores on the mounted globes could be reproduced photographically. We have discovered two different methods which I would briefly like to explain. They have been described in detail in the periodical *Der Globusfreund*, Nr. 25-27, Vienna 1978, p. 47-61.

The first method was developed and tested by Dr. Alfred Kohler, lecturer in History at the University of Vienna and secretary of the International Coronelli Association for Globes and Ancient Instruments. The necessary technical equipment was designed and constructed by Rudolf Schmidt, the president of the Coronelli Association; the actual photography was done by Alfred Janderka, the photographer of the Austrian National Library. The equipment consists of a so-called optical bank, an instrument of high precision, which enables an accurate positioning of the globe and its photographing. It consists of a rail approximately two metres long with a camera on the one side which can be adjusted and on the other an erection to

hold the globe steady. The globe is then held on its meridian ring in such a way that it is able to revolve and its axis is exactly vertical: the equator is correspondingly horizontal. The centre of the globe is within the extended optical axis of the camera.

Success or failure depends on mounting the globe on the optical bank with the utmost care and precision – a task which requires much time and patience; at least two people are needed. A suitable camera is any single mirror reflex camera of high quality with a teleobjective lens (135 mm) equipped for close-up photography. Any black and white or coloured commercial film available can be used (35 mm, 15 DIN = 25 ASA). The lighting should be diffused to keep down the reflexions on the shiny surface of the globe. A few test proofs are recommended in order to determine the correct exposure time, which depends upon the brightness of the globe in question. Certain corrections in the contrast of the photographs can be made during developing.

The entire photographic procedure should take place after these adjustments have been made. For the first photograph the globe must be in the position with the coordinates 0° longitude placed exactly in the optical axis between the camera lens and the central point of the globe; i.e. the longitude 0° and the equator intersect in the middle of the photograph and therefore appear straight. The longitude and latitude in the segment of the photo required is 20° and extends from 10° South to 10° North and from 350° to 10° across. It is better to pick a larger segment which depends on the corresponding distance between camera and object. It is possible fo fit the pictures together by overlapping the surrounding parts of the photograph.

After the first photo the position of the globe is turned along the prime meridian until the point 20° North and 0° longitude faces the camera. The vertical turning of the position is done by a turntable with a compass division. The frequently inaccurate global form requires manual adjustments as can be seen by means of a continual check on the exact position of the globe. This is done by testing the lens finder to see whether the point of intersection

between the corresponding longitude and latitude is in the centre of the photograph.
In the same way the other segments are photographed. The series of the segments for the first nine photographs is as follows:

1. 10° S - 10° N
2. 10° N - 30° N
3. 30° N - 50° N
4. 50° N - 70° N
5. 70° N - 90° N
6. 10° S - 30° S
7. 30° S - 50° S
8. 50° S - 70° S
9. 70° S - 90° S

The longitude 350° - 10° is unchanged. The first series covers a vertical stretch from pole to pole over length of 20° longitude at the equator (on account of the converging meridians the length increases towards the poles). Photo No. 5 reaches the North Pole and Photo No. 9 the South Pole. The prime meridian and the equator appear straight on the series of photographs while the two framing meridians are reproduced as curves. This is the material for the first globe gore.

After these first nine photographs the globe is turned horizontally for the first time at 20° so that in the tenth photograph the coordination 0° latitude and 20° longitude are in the centre; the segment encompasses at least 10° N - 10° S and 10° - 30° E. The ensuing photographs (Nos. 10 - 18) proceed in the same series as photographs Nos. 1 - 9 reset 20° to the East as stated.

The remaining photos are taken in the same way until the whole globe has been photographed. Gradually it is turned in its axis so that there are eighteen gores for every nine photographs. Pictures of the two polar discs are then taken at the end. 166 photographs are needed for each globe.

When the photography has been completed the negatives are developed and enlarged to the original format. The positives are stuck together in the given order – accuracy here is a necessity – and are then cut along the frame meridians. The result is eighteen globe gores from pole to pole and two polar discs. The minimal, ignorable distortions which are bound to occur as the individual photographs meet involve a maximum of 1.5 mm at the equator and are minimised towards the poles. Gores of 30° indicate

considerable inaccuracies and are therefore not recommended.

It is clearly possible to leave the various photographs uncut and to arrange them according to their coordinate rather than stick them together. This should be the case with negatives especially in order to enable the photography of partial regions of the global surface.

The objects photographed with the method described above were the terrestrial globes by Willem Janszoon Blaeu (diameter 34 cm) and Gerard Valck (diameter 30 cm). These were chosen firstly because they are both approximately the same size, secondly because we have no gores and finally in order to document cartography in the Netherlands in the 17th century. The result of the experiment was highly satisfactory. The distortions can hardly be noticed and the photographs look as though they come from a mould. The costs for the films and other material are fairly low, while the average mechanic is easily able to reconstruct the optical bank. This weights 60 kg and should not be moved too often as it is easily damaged.

The disadvantages of the process is the time consuming manual glueing together of the 166 separate photographs which requires great accuracy.

The basis of the second method of planing globes which has been developed in Vienna is electronic data processing. Here too it is possible to regain the plane gores from the finished globe by means of photography. The transformation is based on highly complicated arithmetical and geometrical provisions as well as technical procedures whose rudiments can only be described here. The development and the first practical application of this method took place in the Institute for Photogrammetry at the Technical University, Vienna, (Director: Professor Dr. Karl Kraus) as a diploma thesis by Dipl. Ing. Evangelos Vozikis with the cooperation of the Map Collection and the Institute for Restoration of the Austrian National Library. The globe by Willem Janszoon Blaeu with a diameter of 68 cm from the National Library served as the experimental guinea-pig.

The technical equipment consists of a high-powered camera for 6 × 9 photographs (with a focal length of approximately 150 mm) which enables close-ups without excessive distortions – ' Linhof Technika ' was requires for the

special problem – and of the differential transformation equipment ' Avioplan OR 1 ' from the Swiss firm Wild of Herbrugg. The latter was steered by the computer programm SORA (Software for the Off-line Rectification with the Avioplan). For practical purposes it appeared to be advantageous to make two photographs of each globe gore, each at 25° N and 25° S., i.e. a total of 36 photos plus two for each polar disc. The distance of the camera from the globe's surface is 120 cm; its positioning for the photographed area is of great importance for the subsequent computer assessment.

The mathematical principle of the procedure is that an eliptical cylinder cuts through the globe along the meridians which demarcate a gore (at eighteen gores for a globe this is at a distance of 20° longitude). The points on the globe's surface lying within the gore are projected on the cylinder orthogonally – for the polar discs in Azimuthal projection. The cylinder is then unrolled and displayed as a flat surface. The arrangement of each point on the globe with its identical point on the cylinder and finally on the flat gore is achieved by means of SORA.

Practically speaking this takes place when a beam of light touches the object to be photographed in strips and then forms a flat image of the pre-calculated corresponding points of a negative film by means of a rotating prism steered by a computer.

The output of the ' Avioplan ' consists of the photographed negatives of eighteen gores plus two polar discs. For technical reasons they were reduced in size at a portion of 1:3 in the experiment, which can be used for making positives in the original size.

The result of the first experiment was highly successful. The ensuing gores were of high quality and can be reproduced at any time. The method is very expensive in comparison, but will certainly be applied in the future on account of its accuracy. Once the program has been written, subsequent photographs are sure to be less expensive.