The terrain models of Joachim Eugen Müller (1752-1833): An analytical study using non-contact 3D digitizing techniques.

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18th century progress in surveying and mapping
- Surveys of France and Britain had commenced

Pfyffer's terrain model of Central Switzerland complete

Johan Rudolf Meyer (1739-1813) recognised the need for systematic survey and mapping of Switzerland

Meyer enlisted the geometrist Johann Henry Weiss (1758-1826) to begin work on his project
Pfyffer's terrain model of Central Switzerland 1:11,500, 390 x 670 cm, 1762-1786

Glacier Garden Lucerne
• Both ascend Titlis in the summer of 1787. A carpenter of Engelberg, Joachim Eugen Müller, acted as a guide.

• Müller
  – skilful mountaineer,
  – intelligent observer of topography.

• By the following winter, Müller had constructed a relief model of the Engelberg area and began work for Meyer in the spring of 1788.
Surveying Methods

• Weiss, Müller and Johann Tralles (Bern University) began surveying in summer 1788 around Thunersee
• Later Weiss and Müller continued the survey
• Müller used graphical triangulation
The model at the Swiss Alpine Museum

Model 420.00029 (74 x 48 cm) 1:120,000
Joachim Eugen Müller (1752 – 1833)

Relief of a part of the Bernese Oberland and the Valais 1:120,000
74 x 109 cm, Joachim Eugen Müller, around 1800.

Swiss Alpine Museum
Non-contact 3D digitizers

• Minolta VI-900 laser scanner
  – used in medical science for prosthesis fitting and cosmetic surgery,
  – manufacturing for reverse engineering and rapid prototyping
  – cultural heritage for the restoration and conservation of art objects.
  – operate without touching the object being digitized present minimal risk to that object.
Using the 3d digitizer at the Swiss Alpine Museum

797,132 data points – average resolution was 0.44mm which, at a scale of 1:120,000, equivalent to about 52m ground distance
Shell Registration in Rapidform 2002
Colour map of error in Rapidform
Two scans of the same area taken close-up (left) and at about 1.5 m (right) showing increased noise.
Colour maps of shell/shell deviation in RF during merging of the model 420.0029

standard deviations between +/- 0.279mm and +/- 0.316mm
Müller model after scanning
Georectification
Mapping errors
Mapping residuals
Model adjustment using 1\textsuperscript{st} order polynomial
Residuals after quadratic adjustment
Müller v Swisstopo
Comparing rank order

Swisstopo

Müller

Meyer - Weiss
Sections

Swisstopo

32.1 km

Müller

Niesen

Bietschhorn

Blüemlisalp
Comparisons
Conclusions

• Scientific and objective measures
  – Accuracy far higher than previous attempts at modelling and mapping
  – Must not undervalue Müller’s dedication, skill and artistry
  – Lack of sophisticated equipment
  – Progenitor of a Swiss ‘school’ of modelling that continues today

• Non-contact 3d digitizing
  – Suited to this research and possible archiving
  – Flexible and accurate
  – Enables scientific and objective analysis
Further work

• Map and terrain model analysis
  – we need a better texture output from the scanner
  – Towns and villages could be compared

• Scan another copy of the same model
  – Verify the distortion is in the original or an artefact of copying or distortion over time