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Modeling historical evidence in digital maps: a preliminary sketch

Keywords: Theory of cartography; historical methods; modeling of history; history of cartography.

Summary

The history of cartography has a long tradition in the study of the truth of maps. In 1968 two fundamental articles in *Imago Mundi* appeared that discussed the historical evidence of maps not only from a technical, but also from a functional/contextual point of view: Koeman's: "Levels of historical evidence in early maps" and Harley's: "Evaluation of Early Maps. Towards a Methodology". In this paper we take the herein proposed division of "evidence on, about and of maps" as point of departure for a conceptual model which allows us to examine to which extent existing methodologies concerning the historical evidence of maps can be used in the analysis and design of digital town plans and virtual reconstructions of cities. The model contains parameters of historical evidence based on form, function, (re-)use and transformations of paper and virtual maps and on interpretations of users. Finally the process will be described to allow mapmakers and users to annotate digital maps with information on historical evidence. The proposed paper is embedded in the research programme of the Virtual Knowledge Studio (Amsterdam) and of the University of Groningen (The Netherlands): *Paper and Virtual Cities. New methodologies for the use of historical sources in virtual urban cartography*, http://odur.let.rug.nl:8080/pvc/template/EN/index.xml financed by the Netherlands Organisation for Scientific Research (NWO)

> *By always thinking unto them, I keep the subject constantly before me*
> *and wait till the first drawings open little by little into the full light.*
>   Newton

Introduction

More and more we scan all sorts of sources of our cultural heritage and merge these seamlessly with each other. However, what are the implications of the integration of heterogeneous historical sources for the historical interpretation of these digital maps? The differences in the original and present production and use of maps raise many problems. It is difficult to develop reliable maps based on cartographical sources that vary in scale, precision, colour etc. Especially historical maps of the pre-cadastral period show enormous differences. But even if the technical problems related to these differences can be overcome, questions remain regarding the interoperability of content. Differences in reliability between maps, or between different parts of the same map, are not only due to measurement techniques, but also to their original function and context of use. In short, directly linked with the reliability is the question of the quality of the represented information in relation to its purpose. The history of cartography has a long tradition in the study of truth of maps. In this paper the question will be addressed whether, and if so to which extent, these existing methodologies to describe the concept of truth of maps can be of use to assess the "historical quality" of digital town plans and virtual reconstructions of cities.

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Historical evidence of early maps

For a long time the truth of maps was purely explained from their technical reliability. In 1968, two fundamental articles on methodological aspects of the history of cartography appeared in *Imago Mundi* that might be taken as a point of departure for our exploration of the historical evidence of maps in a more functional and contextual way[1]. Cornelis Koeman indicated six different levels of decreasing value of historical evidence by comparing the uniqueness of the information on the map with written sources and documentation (1968). John Brian Harley, in his publication *The evaluation of early maps: towards a methodology*, proposed to study the evidence on maps, the evidence about maps and the evidence of maps (1968). It is based on three forms of analysis. The first is an internal analysis of the evidence on maps, which investigates the identification and content (mathematical and topographical) and assesses the accuracy and completeness of the data. The evidence about maps is based on external and contemporary analysis. Finally, to establish the evidence of maps, Harley proposed to analyse contextual and historiographical information.

The quest for the reliability and historical evidence of maps and atlases, put forward by Koeman and Harley, would return frequently in the history of cartography[2]. First of all, Harley himself (together with Blakemore) refined his statements and those of Koeman[3]. Furthermore Harley's views were discussed in the work of Denis Wood and poststructuralists fuelled by ideas of Michel Foucault and Jacques Derrida (Wood 1992, Belyea 1992)[4]. The concept of historical evidence in the articles of Koeman and Harley and in these later publications by others was discussed in relation to (early) paper maps. The use of historical sources in the making of digital plans and virtual reconstructions raises the question what this concept means within the context of computer assisted cartography. Although more and more publications are dealing with relations between history, cartography and computers, the use of historical sources and their evidence in computer assisted cartography is apart from some good studies and projects still a research area to be explored[5].

Historical evidence is linked with the concept of (historical) truth. Comparable to the history of cartography, early studies of the truth of digital maps merely focused on technical reliability rather than on functional and contextual aspects of evidence. In this study a conceptual model is sketched and some parameters drawn to evaluate (and to annotate) the historical evidence of digital town plans and virtual reconstructions of cities. However before explaining this model, some problems are tackled that hinder a comparison of methodologies used in the history of cartography and computer assisted cartography.

Differences between paper and digital maps

A comparison of cataloguing standards for paper maps like in the AACR2 for the description of cartographic material or the Multilingual Dictionary of Technical Terms in Cartography of the ICA

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[1] Koeman, C. (1968), pp. 75-80. Harley, J. B. (1968), pp. 62-74.

[2] For an extensive bibliography of this debate on historical evidence see: Wallace, T.R. and Heuvel, C. van den (2005).

[3] Blakemore, M. J. and Harley, J. B. (1980), (1988a), (1988b), (1989), (1990a), (1990b).

[4] Wood, D. (1992); Belyea, B. (1992).

[5] For the use of the computer in historical research: Staley, D.J. (2003), p.75. Black, J.B (1997) and pioneering contributions in Borodkin, L. and Doorn, P. [ed.] (2000). For the concept of truth and evidence in computer assisted cartography and visualization: Chrisman, N. R. (1995) and MacEachren, A. M. (1995). For a good example of a visualization of historical documentation in a virtual reconstruction of a city; see:
http://www.comune.bologna.it/nume/numeindex.htm

with a GIS glossary makes immediately clear that the variations in the terms to describe paper and virtual maps are too many to discuss within the context of this paper[6]. Nevertheless some terms have to be examined to answer the question whether existing methodologies to describe the concept of truth of maps can be of use to assess the "historical quality" of digital town plans and virtual reconstructions of cities. When for example Harley proposes an "internal analysis" of mostly formal aspects of the object to give some "evidence on" (early) maps, we need a comparable basic set of terms like points, lines (arcs), polygons (areas, regions) and raster data, vector data, resolution to describe "formal" aspects or graphic features of digital maps. Data Collection and Transformation Standards and Data Presentation Standards contain terms that similar to Harley's model can express accuracy and completeness. Information to establish the "evidence about" maps, which Harley tried to find in the processes of mapmaking and by revealing the cartographer's intentions could in a GIS environment be explored in the "attributes" and "relations" to (geographic) "entities" (Data Processing and Managements Standards). Finally "evidence of" digital maps might be found in evaluation models of resources and bibliometrical research.

While it might be hard to find an equivalent to describe the digital version of a term defining aspects of paper maps, it is even trickier to use a similar term with a different meaning. To give an example: although in paper maps and atlases sometimes different functions were mixed, we can not simply use a term like "hybrid maps" which in a GIS environment has a specific meaning. However not just differences in terminology but also in the characteristics of paper and digital maps make clear that "traditional" description formats of paper maps used in the history cartography can not be simply transferred to the standards used in computer assisted cartography to label digital maps. The paper map is rather static, while the digital one can be transformed over and over again. The combination of two or more different maps into one "mixed map" is, despite some interesting examples, quite rare for paper maps. Very frequent are such maps for example in GIS where the overlay techniques allow new combinations by a simple mouse-click. The same goes for copies. While copies of a paper map are limited in number and show often differences due to hand-made production, computers can reproduce the same image infinitely. Perhaps we are stating the obvious but the differences between paper and digital maps can not be ignored since they have far stretching consequences for our model of historical evidence. For example, while the uniqueness of the source was the most important factor for Koeman to distinguish levels of historical evidence of early maps, the potency to duplicate the same source over and over again, makes the concept of uniqueness hardly workable within a digital environment. Another difference between paper and digital that must be considered within our model of historical evidence is the issue of time (and space)[7]. Time in historical maps is linear. A sketch precedes the final product and a copy follows the original. However in a digital environment, like GIS for instance, these map forms can be presented in a different order. Layers of different periods are interchangeable with enormous implications for the historical sequence in their original context. Such combinations might have consequences for our understanding of the evidence of the represented historical information in these digital products. Willingly or unintentionally copies can get the same or even a more important status than the original when intermingled in a digital plan or virtual reconstruction of a city. To

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[6] For example *A Practitioner's Guide to GIS- terminology* by Stearns J. Wood alone counts over 10.000 terms.

[7] Vasiliev, I. R (1997), Mapping time, *Cartographica*, University of Toronto Press; Heres, L. (2000), *Time in GIS: issues in spatio-temporal modeling, (Publications on Geodesy 47)* Delft (Netherlands) Geodetic Commission,). For a further exploration of this issue, Heuvel, C. van den, (2004), 'Mapping Mixed Maps. Historical and future constructions of time and space in urban cartography' in *Le temps 129e congrès des sociétés historiques et scientifiques, Colloque IV Le temps des cartes. Monde des cartes, Bulletin du Comité français de cartographie [Numéro spécial decembre]*, pp. 23-40.

give an example: an urban planning committee of a Dutch historical city that, let us say, for the restoration of its seventeenth century centre wants to make use of historical sources to draw a design in CAD or GIS, would probably have a facsimile of sixteenth century map of Jacob van Deventer, a less reliable commercial map of Blaeu based on heterogeneous sources, and several copies of fortification plans (with no information about the street pattern but just the perimeter) at disposal. The combination of these sources in CAD or GIS will bias the digital reconstructions by ignoring that there are far more copies than originals and that the fortification plans have at their very best a limited meaning for the understanding of seventeenth century urban fabric of our example.

Finally there is the issue of manipulation in mapmaking and geographical visualization. Cartographers always have manipulated reality in the process of mapmaking, but the way this has been done is quite different for paper and digital maps. While for paper maps and atlases the process of making and editing can be followed in different steps by following preliminary sketches, designs, engravings, corrections and addenda on copperplates and by studying different states of printed copies, in their virtual form these processes are very often implicit and difficult to reconstruct. Not only the production, but also our "consumption" is different for digital maps. Whereas the design and analysis are distinct for paper maps, in computer assisted cartography these activities are becoming more and more indistinguishable. Moreover in a process what Morrison has called the "democratisation of cartography" the map user no longer depends on what the cartographer puts on the map, but also becomes cartographer (Morrison 1997)[8]. This can lead to differences in the "authorities" of manipulations. In short for the modelling of historical evidence it is not only important to look at maps, but also at their users. In addition to the analysis of formal and functional/contextual aspects of maps a representation of (historical) interpreters and editors needs to be included in our annotation system.

Differences in terminology of historical evidence

Not only terms to describe the production and use of maps, but also definitions of historical evidence differ. Authoritative dictionaries describe evidence as "material items or assertions of facts as means of ascertaining the truth", or more generally as "indication" or "ground of belief"[9]. But what are these "material items of assertions of facts" in a historical context? To which extent can they build up to ascertain "historical truth"? Both in the context of history of cartography and computer assisted cartography the term (historical) evidence is not used in a consistent way. Koeman's division in six levels of historical evidence is merely based on the uniqueness of the source as a testimony of an event or fact and much more restricted than Harley's evaluation areas "on", "about" and "of" maps. In computer assisted cartography the term (historical) evidence is hardly used[10].

However many other terms contain elements that might be considered "indications" of (historical) truth: Unwin gives an helpful classification to give an indication of closeness to truth: ' "error is the difference between reality and the digital representation of it, blunders are simply mistakes, "accuracy" is the closeness to results, computation or estimates to values accepted as true, preci-

[8] Morrison, J.L., (1997), Topographic mapping for the 21st Century, Rhind, D. (ed.) *Framework of the world*, Cambridge.

[9] These definitions are from the Merriam Webster Dictionary on line http://www.m-w.com/ and the Encyclopedia Britannica online http://www.britannica.com/

[10] For a rare example of a more practical introduction to historical evidence in paper and digital maps: D. Stephens located at http://historymatters.gmu.edu

sion is the number of decimal places given in a measurement [..], quality is the fitness to purpose of the data; and uncertainty measures the degree of doubt or distrust when using the data' (Unwin 1995)[11].

Most of these terms are used within the context of geographical information systems. Geographic space can be measured with distinct levels of precision and accuracy, but historic events and processes are not quantifiable as such. Although the Oxford English Dictionary defines "truth" as "conformity to fact or actuality", for a definition of historical truth, one must settle for something less concrete, like "in keeping with the most widely accepted interpretation of the historical event or process"[12]. This later definition implies that it is not enough to analyse and visualize quantitative or qualitative data themselves, but that also interpretations hereof need to be included in the model.

A preliminary sketch of a conceptual model of historical evidence in paper and virtual maps

After this quick scan of differences between paper and digital maps, between methodologies of history of cartography and computer assisted cartography and of their possible implications for interpretations of historical evidence we try to sketch the outline of a possible model (fig. 1).
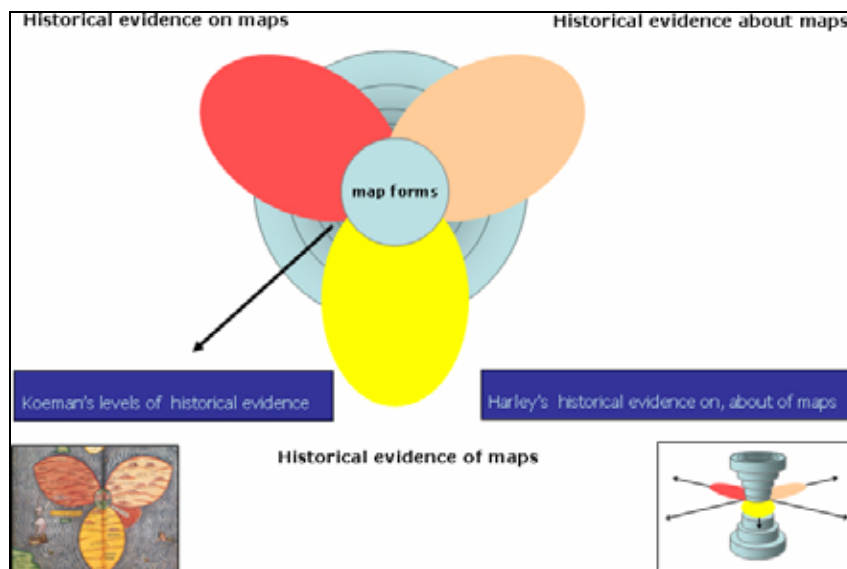

Figure 1. Visualization of the interpretations of historical evidence of Koeman and Harley.

This outline is inspired on the well-known world map with Jerusalem in the centre of Heinrich Bünting (1581). His depiction of the three continents of the Old World becomes a metaphor of the three fields of exploration of evidence on, about and of early maps of Harley's approach. The centre is formed by map forms with different levels of historical evidence derived from Koeman's model. The fields contain indicators of evidence on, about and of maps. To this Koeman/Harley model are added three parameters based on quantifiable information on historical evidence that cross the three overlapping fields of exploration. Moreover there are two additional parameters that

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[11] Unwin, D.J., (1995). Other useful classifications of accuracy in Blakemore and Harley (1980) MacEachren (1995), Chrisman, N. R. (1999) and Foote, K. E. and Huebner, D. J. (2002). For an analysis of these different classifications see: Wallace and Heuvel (2005).

[12] See Wallace and Heuvel (2005), p. 173.

reflect degree of uniqueness (Koeman's levels of evidence) and degree of transformation (See, fig. 3). We see the image in two dimensions from above, but in reality it is a three dimensional model (See, fig. 2). So the three fields of exploration are in reality three-dimensional. That means that the parameters (z axes) in these exploration fields are (not necessarily one-directional) vectors that connect points in a material or virtual space, or sometimes in both.

A classification of paper and virtual maps and atlases in relation to historical evidence

Most classifications in the history of cartography distinguish maps according to formal aspects, according to projections, according to function and so on. However often these categories are not refined enough to describe the variety of the maps and drawings, used for urban planning and restoration, let alone to describe the mixed form of digital town plans and virtual reconstructions of cities in multimedia. In my dissertation *'Papiere Bolwercken'* (Paper Bulwarks) of 1991 I have tried to refine some categories of military topographical maps and town plans used in the history of cartography by combining these with typologies (existing and new ones) of fortification plans and architectural drawings[13]. However it is not enough to refine existing categories further and further. Many of such sub-categories remain too rigid to describe the mixed forms of maps and atlases. If it is so hard to make a distinction between these map forms we better describe them in more general terms. Woodward and Malcolm Lewis used the term "mapness" to express their difficulties with hard definitions. (Woodward and Malcolm Lewis 1998)[14] In an article on defining and digitising military manuscript atlases I introduced a similar neologism: "atlasticity", which also might be of use within the computer-assisted cartography, since by the combination of digital plans virtual atlases are created. (Heuvel 2003)[15] This less rigid classification scheme of maps and atlases is in our model brought in relation to the concept of historical evidence. (fig. 2).

Along a vertical axis different forms of paper and virtual maps and atlases are piled up in opposite directions[16]. Closer to the horizontal line that separates paper from digital maps are the formats that can be easier identified as maps at the basis of form, function and interpretation. Towards the extremities we get copies, reconstructions, maplike forms, fake simulacra, diagrams, ideograms and schemata with no spatial relationship at all.

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[13] Heuvel, C. van den (1991), ch. 3.

[14] See, Woodward, D. and Malcolm Lewis, G. (1998) p. 6.

[15] Heuvel, C. van den (2003).

[16] Although many visualizations are three-dimensional forms for the moment we have only included two dimensional paper and digital plans in our research.
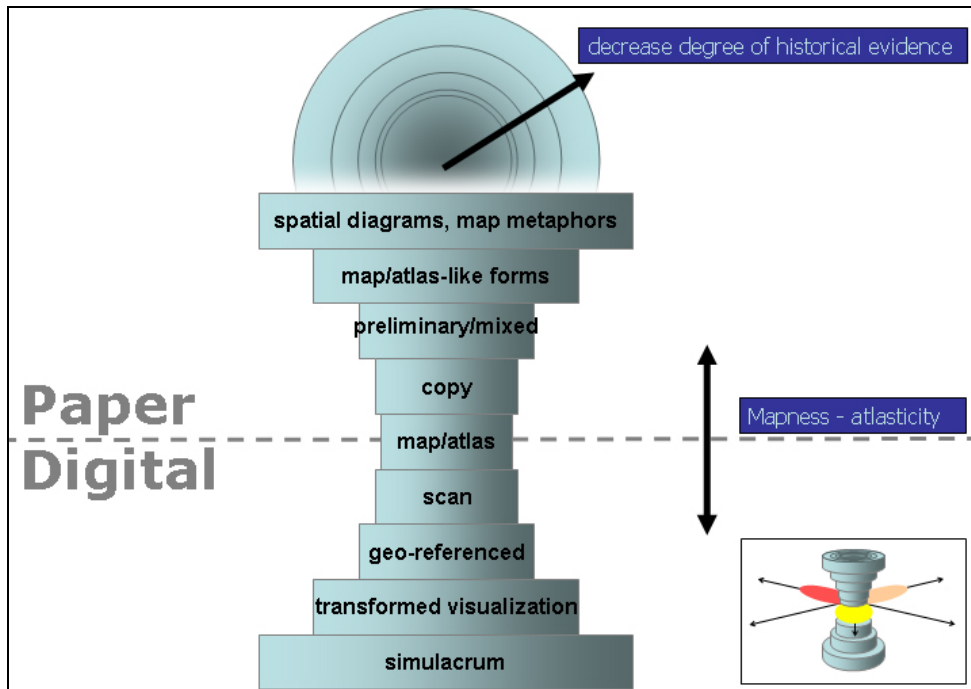
Figure 2. Paper and Digital Map Forms: "mapness" and "atlasticity" in relation to decreasing degree of historical evidence.

Exploration fields of evidence and historical research methods

Also on a horizontal level these maps forms become wider and vaguer to express the blurring of our vision. In short while the y-axis expressed the degree of mapness (yes it shows a high degree of evidence, but is it still a map?), the x- axis shows various degrees of evidence (yes it is a map, but does it give evidence?). The assumption is made that for its completeness of information and for the consistency in historical interpretations of different users, the map that is closest to the x and y axes is the best source to give historical evidence. As such there is a relationship with the three exploration fields of historical evidence on, about and of maps. The fields to explore become wider when the object of research is less identifiable (fig 3).

The exploration of the historical information in the model of Harley focuses on formal aspects for the identification of the map. As stated here above, the terminology to describe these aspects is often quite different for paper and digital maps. For the identification of a paper map in our model we can choose for example the category watermarks, while under the horizontal line we might think of the term digital signature. Apart from identification, which in digital form is much harder than in its paper version, these fields contain information about accuracy, precision and/or error of maps which might give an impression of the reliability of the map in a technical sense. This information is for the greater part quantifiable: size, scale, resolution etc.
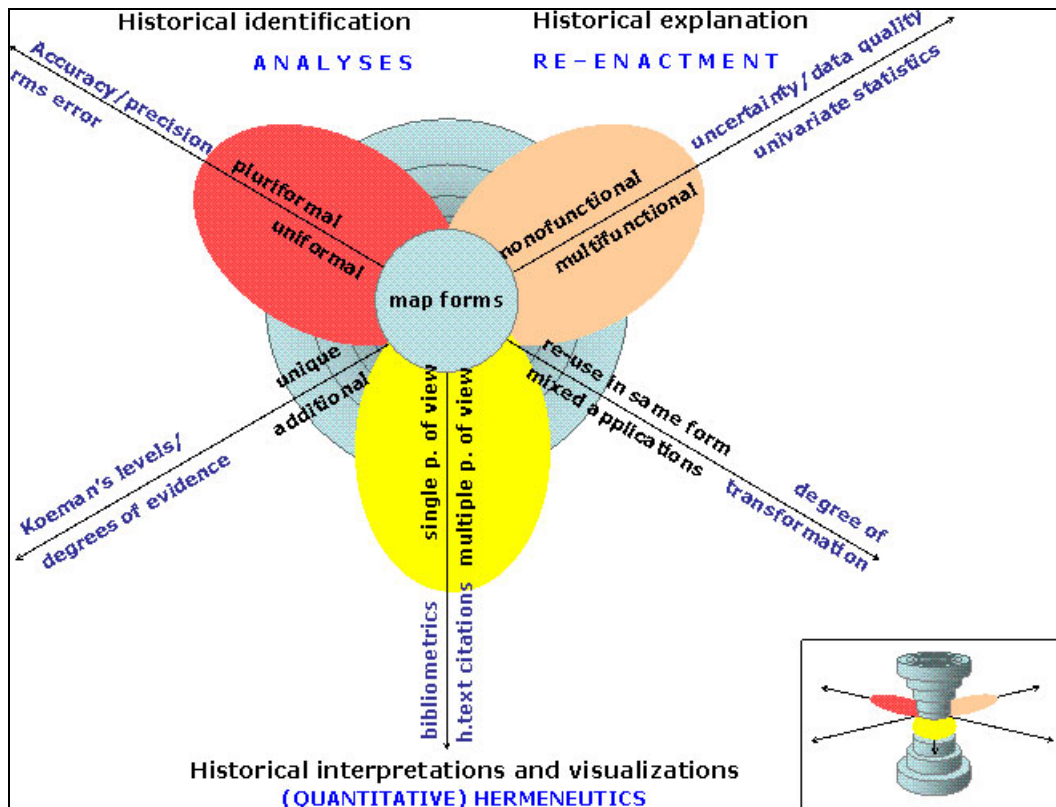
Figure 3. View from above of 3d model of historical evidence in paper and digital maps.

The exploration of evidence about maps is not based on quantitative analysis, but rather follows indications of the quality of information. To explain the quality and accountability of the data (defined as fitness to purpose) we need to focus on the function of maps and on contexts of use. Harley studied the evidence about early maps by reconstructing the production process, the intentions of the cartographer and by analysing views of contemporary users. In its digital form the design and analysis of maps are far more integrated and implicit. The how and why historical information is produced or edited in that way asks for a careful contextual examination of the "attributes" of maps.

The exploration of the historical evidence of maps is foremost a study of the perception hereof, rather than of their form, function or contemporary use. Although historians of cartography always have quarrelled about the meaning of maps, the contours of the disciplinary battlefield and the competences of the competitors were for the experts somehow settled. In 1972 Skelton was able to define the boundaries of the history of cartography and cartographical history[17]. These boundaries are blurring when design and analysis and producers and users of maps become interchangeable. This asks for new ways for exploring and visualising historical interpretations.

The study of historical evidence on, about and of paper and virtual maps ask for different methods of historical research. For evidence on maps we will use historical analysis. To reconstruct the evidence about maps within the processes of making and using these products we consider historical re-enactment and heuristics useful[18]. Finally historical hermeneutics that includes the (visual) perception in a more holistic view might be of interest to tackle the relation between objectivity and

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[17] Skelton, R.A. (1972) p. 62.

[18] Martin, R. (1977).

subjectivity of interpretations[19]. Furthermore we are in need of evaluation tools that allow to read the authority and appropriateness of the resources and to include personal criteria for the assessment of the value of the historical evidence of maps. It is important to note that these three different forms of historical action, like the history on, about and of maps, are interrelated. Like oil fields these three exploration areas of evidence might be clusters of "indication points" that become denser closer to the source. In order to find and to asses the quality of our 'resources' we are in need of indicators and parameters of historical evidence.

Indicators and parameters of historical evidence

The first parameter is used to analyse formal information of the map. Some elements can only be analysed in a paper (chain lines) or a digital environment (resolution), others in both (size, scale etc.). However they have in common that the information is for the greater part quantifiable. Accuracy, precision and error can be measured and expressed in quantities (for example National Map Accuracy Standards for accuracy and the Root Main Square (RMS)- factor for error). For the qualitative description of evidence about maps, based on function and context of use, it is difficult to work with hard parameters. We rather look for indications of the quality of information and assign a value of the (historical) function of maps in relation to its use. Hereto we distinguish an axis running from monofunctional/univariate (single attribute) to multipurpose/non-functional and one that expresses single use and multiple applications. For example, the abovementioned maps of Jacob van Deventer contain both topographic elements and a depiction of the fortifications, while a fortification plan often just shows the perimeter but not the internal street pattern of a city. When we are dealing with a reconstruction of the walls of a city the fortification plan might score higher while the Van Deventer maps scores lower for function. However in case the city centre would be restored the Van Deventer map scores higher as a historical source than the fortification plan.

Function is not the same thing as use. A copy might be re-used in the original form, but sometimes it was re-used in a different or mixed form. For example fortification plans were re-used to make decorative atlases. The editing in order to make the map suitable for this different purpose might affect the evidence of its content. Although we assign values to the function of maps in relation to the use thereof, the qualitative information on which this evaluation is based remains especially for the paper maps rather descriptive. In computer assisted cartography some indicators and parameters are used that represent qualitative aspects of digital maps in relation to function and use, like data quality and uncertainty. The fortification map of our example got a new function. However it still might score high for historical evidence as an unique source. This brings us to the third parameter that reflects Koeman's idea of levels of historical evidence based on uniqueness. This axis stretches from only and unique source of evidence to one of more and an additional indication of confirmation. In stead of levels we prefer a gliding scale of degrees. Related to this degree of uniqueness is the fourth parameter that describes the degree of transformation of the used source. In a digital environment framework, filters, plug-ins etc. enable the user to control which forms and which parts of a topic map are shown to him. An editing parameter monitors this process of (customized) transformation and may indicate to which extent information is blanked, skipped, faded or distorted[20].

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[19] For hermeneutics and visualization: Davey, N (1999). For hermeneutics and urban cartography: Speet, B.M.J. (1987).

[20] Compare: methods and apparatus for customized editing of video/and or audio signals. United States Patent 6337947 on http://www.freepatentsonline.com/6337947.html

The fifth and last parameter reflects the variety in (historical) interpretations. Consensus is hard to define. However with the help of bibliometrical research and citation maps we might be able to analyse and visualize to a certain extent the variety and authority of the different interpretations. Quantitative hermeneutics might enable to recognize consensus and trends in information[21].

Finally there are strategies for evaluating the diversity and quality of information that combine aspects of the abovementioned parameters and indicators. One of the instruments that could be of use to assess the accountability of the selected sources and contextual information is CARS. The CARS-checklist stands for Credibility (author's credentials, evidence of quality control) Accuracy (up to date, factual, exact and comprehensive) Reasonableness (fairness, moderateness, consistency) and Support (sources cited).

Paper and Virtual Cities and Historical Evidence: Four interrelated projects

So far we have described an outline of a conceptual model of historical evidence. In this stage is not more than a preliminary sketch which only partially can be worked out. First of all this is due to limitations in the presented visualization of the model. Although we have mentioned that the model was intended in 3D, the exploration fields of evidence in, about and of maps are still represented one-dimensionally. The same applies to the representation of the parameters as straight lines which in reality are vectors that point in more, i.e. three dimensional, directions through the 3D exploration field. We hope to work this sketch out in a more advanced simulation model. However the completion of this model is not only limited by constraints in the visualization possibilities of power point, but also by the usual, more down to earth conditions of a research project: time and money. So, not every aspect of this conceptual model can be worked out completely and like some many other paper and virtual cities it will remain an ideal model in the head of its maker. Nevertheless, thanks to the financial support of the Netherlands Organisation for Scientific Research (NWO) we are able in our research programme Paper and Virtual Cities to work out methodological issues regarding research ideas on technical reliability, historical evidence, visualization and annotation in four interrelated projects.

Measuring the historical city

By studying historical land surveying and mapping methods and using this information in the development of digital maps and virtual reconstructions, errors can be minimized and the processes of rectification refined. Hereto we try to develop a "qualitative" typology of ground control points (GCP's) based on design points, surveying points, mapping points and copying points[22]. In our model of historical of evidence these "quality" ground control points are the indicators that together with parameters like rms factors give information about the technical reliability of paper and digital maps and atlases.

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[20] Compare, Martindale, C. and West A.N. (2002).

[21] See further the contribution of Jakeline Benavides and Elwin Koster in this Workshop.

[22] See further the contribution of Elwin Koster in this Workshop.

Contextualizing the virtual city

The media-guru Marshall McLuhan explained how the invention of printing transformed the content and context of information of manuscripts (hence his famous dictum the medium is the message). The same applies to the translation of cartographical sources from paper into digital form. By combining (parts of) maps made for different purposes and (re-)used in different historical context also "messages" are mixed. This asks for a study of the map as a historical source and of quality of data used in the development of digital town plans and virtual reconstructions of cities. This information is used to assign values to maps for historical evidence based on function and context of use.

Visualizing the historical city

In the abovementioned projects we assess the technical reliability and evidence of the sources in relation to function and context of historical maps. In this project we extend our view to the digital town plans and virtual reconstructions of cities by questioning the way historical information of the city has been represented herein. How can the user distinguish between necessary manipulations and deliberate distortions to falsify the truth? How can the user read virtual reconstructions in a critical way in order to assess the reliability and veracity of historical representations? Can they detect (possible hidden) purposes of these reconstructions? Can they figure out why the reconstruction has been presented as it has and how the historical information has been edited? To answer these questions we focus on the editing of historical information in digital media. The analysis and combination of geographical, historical and cartographical approaches can be useful to develop a set of parameters to read visualizations of history in digital town plans of virtual urban reconstructions and to establish the implications of editorial choices in the representation of historical sources to users.

Coding the virtual city

In the process of digitization we risk a loss and a change of content and context. To make the user aware of these risks of reduction and distortion the model foresees in an annotation system. By means of draw-on-images polygons can be created to compare certain parts in or between maps. To these polygons information is linked which can be descriptive, a comment on content and context or an assigned value of historical evidence. Moreover as become clear from the scheme of the process of annotating (fig. 4) users can express their own point of view in separate annotation layers. This information will be described in XML.

The research is directed on the development and testing of a mark-up language which allows the coding of historical information for digital maps[23]. The Geography Mark-up Language (GML) project of the open GIS workgroup provides a geographical mark-up language, while the Historical Event Mark-up and Linking project (HEML) contains useful elements to annotate digital maps with historical information [24]. However in contrast to HEML, the proposed marked-up language does not allow the description of " historical events" but enables to include primary and secondary sources that describe and "illustrate" historical processes. Morover the language allows more au-

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[23] http://www.heml.org/

thors to describe and to visualize different interpretations (reconstructions) of the same historical events and processes. By combining mark-up languages with existing standards, a new XML standard for the annotation of historical data can be developed. The programme offers an export possibility to the XML-based vector standard SVG (Scalable Vector Graphics).

Paper and virtual cities. Modeling evidence, modeling history (synthesis)

As the title Paper and Virtual Cities suggests the research will come together in paper and in digital form. A book explains methodological aspects of the use of historical sources in computer assisted cartography and must include a further elaboration of this rather rough sketch of a model of historical evidence. The synthesis in digital form will consist of software that visualizes the historical evidence of the maps. The idea is that the user when moving the cursor over a digital map, by means of a matrix that pops up from it, gets information about the underlying historical sources in relation to their original function and context and can assess whether this suits his/her intentions in research, planning or design. Moreover he or she can annotate the map with own insights. By this input not only the producer, but also the user will be modeling historical evidence of digital maps. Producers and users will not only be working on an always changing model of evidence, but also be modelling history.

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