From the ice age to the present – an audiovisual and tactile model of the Göta River Valley in Western Sweden

FROM THE ICE AGE TO THE PRESENT – AN AUDIOVISUAL AND TACTILE MODEL OF THE SWEDISH REGION GÖTA RIVER VALLEY

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ABSTRACT:

This paper describes a project in progress dealing with visualization and mediation of archaeological and cultural heritage information by integrating digital tools in a museum exhibition. In the project an interactive, combined digital and physical model representing the Göta river valley in south-western Sweden is developed. The objective is to utilize audiovisual and tactile information to illustrate the historical development of the region and to communicate historical knowledge in a museum environment in an innovative manner. Although the project is directed to all museum visitors, the focus audience consists of young students and visually impaired. The model comprises three parts: an animation, an audio track, and a tactile model. The animation, together with the audio track, illustrates the landscape development of the valley from the ice age until present. The animations are based on spatial data and calculations for land uplift and shoreline-displacement. The tactile model functions as a background for the projection of the audiovisual component and as communication interface to the visually impaired through a number of unique surface finishes. A first version of the digital model was installed at Lödöse Museum at the end of 2007. In November 2008 the combined model will be inaugurated and an evaluation of the visitors' perception of the model initiated. Feedback has been gained continuously from museum staff and visually impaired, which has influenced the production of the final model. The results of the study will improve knowledge about the impact of digital applications within archaeology and the cultural heritage sector.

1. INTRODUCTION

1.1 Background and aims

Technical developments over the latest decade have had significant influence in the field of archaeology and cultural heritage management. Digital applications have had a considerable impact, particularly on data collection and field documentation methods (e.g Conolly & Lake, 2006; Stenborg, 2007; Wheatley & Gillings, 2002). However, the dissemination of this kind of information to the public by means of digital methods and data is still comparably uncommon.

The paper describes and discusses a project in progress which deals with digital visualization and mediation of archaeological and cultural heritage information by integrating digital tools in an ongoing museum exhibition. In the project an interactive, combined digital and physical model representing the Göta river valley in south-western Sweden is being developed for museum visitors. The objective is to utilize both audiovisual and tactile information to illustrate the historical development of the region and by that to mediate historical knowledge in a museum environment in an innovative and unique manner. Although the project is designed to communicate information to all museum visitors, the main focus audience within that sphere consists of young students and the visually impaired. Visualizations and models must hold a certain design quality in order to generate relevant response (Neto, 2003) at the same time it is important to emphasize the content, i.e. the empirical information which is communicated. An overall question is how empirical objectivity and authenticity can be combined with and balance visually convincing representations.

1.2 Overview and reference to related work

During the last years 3D techniques, Virtual Reality (VR) and Augmented Reality (AR) have been increasingly implemented as a pedagogical tool for visualization and mediation of archaeological and cultural heritage management information (Lock, 2003; Tringham, 2004; van Raalte et al., 2004). Examples include: Time based information and communication of historical maps online in the form of map animations, e.g. the Australian TimeMap Project (www.timemap.net/, Johnson and Wilson, 2003; Johnson 2004), and the possibility to fly around in virtual environments based on historical maps draped over a digital elevation model, e.g. the Swedish Djurgården landscape project (www.djurgarden.se/landskapet/). These examples include a time perspective, but communicate historical information only digitally and do not address target groups such as visually impaired.

The use of relief models and tactile surfaces for information mediation together with an audio track to visually impaired (Almeida/Vasconcellos & Tsuji, 2005) and in museum environments is not new. However, usually historical landscapes or sites represent one specific time period and rarely

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include changes through time. It is even rarer that they include time series directed to communicate with the visually impaired.

In the project Västsvenska Handelskammaren (2003) different types of geographic data were projected on a physical model to visualize population structures, occupations, transport systems, etc. and were able to be selected interactively. In the project a digital and physical model is combined, however, only one time frame is illustrated and the physical model is only explored in a visual way.

The Göta river valley project "From the ice age to the present" intends to fill some of the above mentioned gaps. A digital and tactile model is combined to illustrate and communicate the historical development of a region, implemented into a museum environment and with focus on the accessibility for visually impaired. The concept is being tested in cooperation with an archaeological museum in south-western Sweden, Lödöse museum (www.lodosemuseum.se), where the combined model will be integrated in an ongoing exhibition about the history of archaeology: "Images of our ancestors". This exhibition focuses on the history of archaeology and how differently the traces of our ancestors have been interpreted during time. This exhibition also incorporates a number of learning stations for school classes. The Göta river valley model is thus a component of one station.

In the following text, the digital and tactile models are described in detail; how they are constructed, what data they are based on and what content they will house.

2. DIGITAL MODEL

2.1 Animation

An animation of the historical development of the Göta river valley has been created with the objective to compile and communicate existing knowledge from different sources in a new, visual and pedagogical way. The animation illustrates the development of the cultural and natural landscape of the valley area from the end of the last ice age (12500 B.P.) to the present day, and will cover an area of roughly 3000 km^2 illustrating the following themes: shoreline-displacement (due to sea-level fluctuations and glacial isostatic adjustment), vegetation development, land-use and agriculture, human occupation and settlement, routes of communication, and archaeological sites. To take into account the needs of visually impaired, the choice of distinct colors, contrasts, and light quality is essential.

A first version of the animation was based on a geographic information system (GIS) model generated using ArcGis 9.2 (www.esri.com) and XTools Pro 5.0 (Figure 1). In order to produce a smoother animation, the final version will be key-framed in a professional animation program.

A 25m interval grid digital elevation model (DEM) was interpolated from a 50m interval point lattice obtained from the GSD-Terrain Elevation Databank (National Land Survey of Sweden, www.lantmateriet.se) for use as the main elevational base-dataset in the model.

Simulation of the past sea level was implemented through a mathematical algorithm, developed by professor Tore Påsse (Klingberg et al., 2006; Påsse, 2003; Påsse & Andersson, 2005), whereby the prevailing situations at nine points in time were simulated. Additional "time-frames" were generated by several other procedures, including contour functions and tools for buffering. Figure 2 illustrates some of the time slices of the animation.

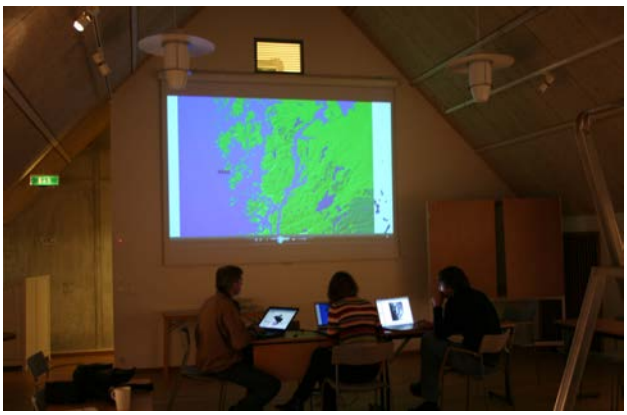

Figure 1: The exhibition hall at Lödöse Museum. A first version of the digital model, the animation, was installed at the end of 2007 and projected on a vertical screen. Photo: Per Stenborg.

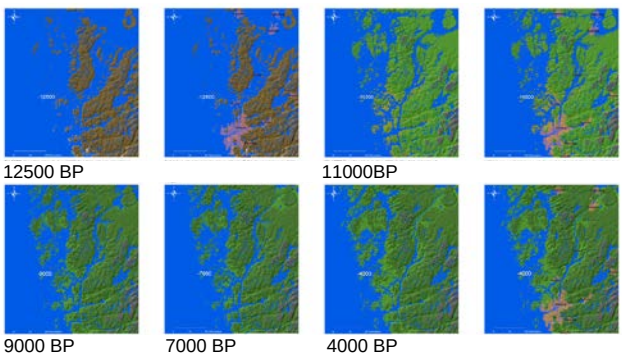

Figure 2: Images from the animation of the Göta river valley landscape: shoreline-displacement for the time periods 12500 B.P./11000 B.P./9000 B.P./7000 B.P./4000 B.P.. Per Stenborg.

Do not use any low contrast photocopying For the illustration of the vegetation development, layers will be built from the results of pollen analyses of samples taken in bogs and lakes in Western Sweden (Persson, 2003; Welinder et al., 1998; Ytterberg, 2006). These layers will simulate the proportional distribution of vegetation types, rather than the precise presence (or absence) of particular species. The present vegetation distribution and land cover is illustrated by data from the GSD-Land and Vegetation Cover database (www.lantmateriet.se). Further, historical maps will be investigated as a source of data to accomplish the description of vegetation development in the Göta river valley. The animation will not only show the proportional distribution of the vegetation but also contain pollen-diagrams to illustrate what the interpretation in the animation is based upon.

Different categories of archaeological sites derived from the Swedish National Record of Sites and Monuments (FMIS, www.fmis.raa.se/) will also be included in the animation. It is important to communicate that these sites only represent known sites, whereas the "real" number of sites may be considerably greater. This theme will allow discussing the issues of the role of interpretations, empirically gained knowledge, authenticity and visual experience.

Communities are represented by vector polygons which define their area and location. During the animation the outline of the communities are as they are today to give the visitors the possibility to relate the animated process to known geographic reference features. The origin and growth of these communities will also be animated from a time perspective. Additional information to include in this component of the animation may be communication routes and landmarks.

Another idea is to link the historical development to topics of current interest such as climate and environmental change, or green house gas effects. This will be realized by comparisons between phenomena such as the flooded settlements of the Mesolithic era (as a consequence of transgression periods) and current fears of sea level rise caused by global warming. Thus, two hypothetical future scenarios of the landscape development of the Göta river valley will be added based on these parameters.

2.2 Audio track

The animation is accompanied by an audio track which aims to explain the themes of the model in a pedagogical manner. As the overall exhibition is mainly directed towards school classes and younger teen-agers, a 15 year old girl was chosen as speaker. The audio track has also been adapted to suit the visually impaired. For example, explanations of the animation content are balanced with descriptions of the underlying model and events of the animation, i.e. what you can see right now in the animation. In the first version, the audio track will consist of a spoken monologue in Swedish and English. In a later, revised version of the audio-visual animation sounds representing different time periods may be included. These sounds may represent the natural environment or the sound related to humans activities.

The audio track starts with an overview of the composition of the exhibition room, the course of events about to be shown and an introduction to the main feature of the room (i.e. the digital-tactile model). The objectives of the model are mentioned, the principals of the seven tactile surfaces and their information content introduced (see Chapter 3), as well as how to use the tactile model. Next, the screenplay of the animation is described and the possibilities of interaction are explained. Thereafter, the overall composition of the model is described. The animation then runs and halts according the story; e.g. to describe and explain dramatic changes of the shore-lines, or when areas or places of particular interest become visible. A description of the depictions of the landscape's composition at particular moments in time is provided along with an account of the processes of change illustrated by the animation. Also, scientific backgrounds are given concerning the interpretations of historical situations (e.g. researchers may have found pollen of birch trees and may allocate it to a particular time period).

The introduction part of the animation audio track may also be combined with the DAISY digital guide (www.daisy.org) the museum uses for the related exhibition "Images of our ancestors". The audio track is produced by a professional sound technician. The animation (inclusive audio track) will not only be presented at Lödöse Museum but also online via the homepage of the Digital Time Travels project; http://www.time-travels.org.

3. TACTILE MODEL

As mentioned above, the development of the Göta river valley from the Ice Age to present is not only modeled digitally but also physically. A tactile model of the valley at a size of 1,20m x 4,27m (fits 2 x 16:9 widescreens) has been constructed with the objectives a) to function as a background for the projection of the audiovisual model, and b) to communicate historical information to the visually impaired. For that, the relief of the Göta river valley topography is combined with a number of different surface treatments. Therefore, the most challenging part is the design of the time perspective and the balance of the information load.

The tactile model represents present day topography of the landscape on which three time periods after the ice age are illustrated. The topography of the model is constructed based on contour lines calculated from DEM and printed on a paper map covering the entirety of the tactile model.

Altogether, the model contains seven different tactile surface structures with the following information content: a) a glossy surface representing water surfaces, b) a convex raster surface representing land area at the time 12500 B.P., c) a smooth surface representing the time period 12500-7000 B.P., d) a sandpaper-like surface representing the time period 7000 B.P. until present, e) a waffle-shaped surface representing the area of distribution of present day population centers, f) pin-points marking the eight archaeological sites which are presented in more detail in the museum exhibition, and finally g) Braille of the names of the settlements and archaeological sites. The transposition from one time period to another and the borders of the settlements are very clearly marked by convex lines. A further measure to improve the tactile properties of the model is the exaggeration of the height by a factor of approximately ten.

The physical model is one solid model, manufactured by the Academy of Shaped Design in Lidköping, Sweden (Figure 3, Formakademin, www.formakademin.se) and constructed in three steps

- A positive model in clay, constructed over the isoline map on a base of 5 mm foam boards. The step-like differences in height are leveled out with clay and water surfaces are modeled by a window pane (Figure 4).
- A negative model in gypsum. The clay model functions as mould for the gypsum cast.
- A final model in epoxy. After drying of the gypsum model and treatment with linseed oil, the tactile model is produced in the plastic material epoxy, and will have a weight of about 70-80kg.

The final surface treatment is a spray paint in a grey color nuance (Natural Colour System®: NCS S-4500-N) to provide the best conditions for the animation with regard to contrast and color projections. The tactile model, then, is placed on a stand which is mounted on the floor in the exhibition hall at Lödöse Museum to avoid unwanted displacement, though this will allow the model to be moved temporarily, as the exhibition hall is also used as auditorium. Once on the stand, the model has a similar shape to a table and has a free height of about 70cm to enable wheel-chairs access to at least a half of the model and to offer a comfortable height for people to easily interact with it.

Figure 3: Towards a tactile model. Students at the Academy of Shaped Design in Lidköping manufacture the positive clay model (1,20m x 4,27m). Scale 1:20000. Photo: Liane Thuvander.

Figure 4: Step one, a positive clay model based on foam boards. The white lines mark the crossing of time periods. Photo: Liane Thuvander.

4. A COMBINED DIGITAL AND TACTILE MODEL

Finally, the audiovisual and the tactile model are combined with the purpose to increase the experience and accessibility of historical information to a broader segment of the public. The animation is projected by two high resolution (HDMI) projectors installed above the tactile model (Figure 5). A crucial part is the synchronization of the tactile model and the projection of the animation to get an as good as possible correspondence between the information content of the digital and tactile model.

The animation will occasionally halt to explain the course of events. Interaction related to the animation is realized via a touch-screen enabled computer station next to the tactile model table. One can start or stop the animation whenever wanted, select parts of the animation, change the language and finally choose between two different future scenarios related to the rise of the sea level.

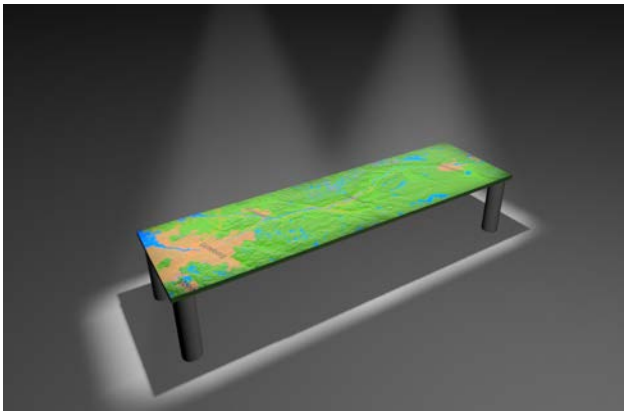

Figure 5: Animation projected on a tactile model specimen. A virtual mock-up of the Göta river valley.

5. DISCUSSION - FEEDBACK AND EVALUATION

The whole modeling work is based on formative feedback and evaluation processes and is carried out iteratively. New competences and cooperation partners are linked to the project as needed. For the audiovisual and tactile model, the continual feedback from museum staff and a representative of the Swedish Association of the Visually Impaired has been used as guideline for the modeling work. Various methods for feedback and evaluation have been and will be applied, such as meetings with different actors, focus group interviews, surveys, video filming, and feedback from a scientific reference group.

The overall design of the audiovisual and tactile model is the result of the cooperation of the project group and staff from Lödöse Museum and the representative from the Swedish Association of the Visually Impaired. After installing a first version of the animation (Figure 1) the scenario idea came up by the museum staff to improve the pedagogical and interactive part of the model. Another idea was to integrate the model with the ongoing exhibition “Images of our ancestors”, something which did not form part of our initial plans. In this exhibition, Lödöse Museum focuses on accessibility for the visually impaired and an integration of this into the digital model was needed, which was a real challenge. Thus, the idea of the combined digital and tactile model was born. This part is mainly based on internal feedback and evaluation (project group, museum staff, representative for the visually impaired).

5.1 Creation of the digital model

The animation is commented by the museum staff from a pedagogical point of view. The scientific reference group has provided feedback on the content and technical issues such as choice of software. For discussion and improvement of contrast and color settings and finding an appropriate speed for the illustration of changes, an informal group interview/focus group interview will be carried out with two to three persons having different levels of impaired vision.

The manuscript for the audio track is written and revised continuously by the project group after being commented by the museum staff from a pedagogical point of view and by the representative from the visually impaired perspective. A speaker voice test has been evaluated by the project group members, the museum staff and the visually impaired.

5.2 Production of the tactile model

Several model prototypes have been manufactured in order that a representative of the Swedish Association of the Visually Impaired would be able to test different tactile surfaces and structures of the physical model (Figure 6). From the test results, decisions are taken regarding what kind of structures to include, the sequence of the structures, etc. One lesson learnt is, for example, that convex structures work much better than concave structures and information overload must be avoided as visually impaired persons only can manage a limited number of different information content. The tactile model can be revised during the production phase, however once it is produced, options for modifying the surface become limited. Therefore feedback such as this at early stages is critical to the production of a useful tactile surface for the model.

Another discussion has dealt with the question of how many pieces the model should consist of. One piece is preferable considering the projection and from an esthetic point of view. From a more practical point of view, the idea of dividing up the model into four pieces was initially discussed. This would allow the museum staff to be more easily able to move the model as needed. However, this solution raised problems regarding how to secure stability, fitting joints and correct projection of the animation. In the end, the museum was able to come up with a solution for handling a one piece model on a removable stand.

Figure 6: Visually impaired test of different tactile surfaces for the physical model. Photo: Liane Thuvander.

The design of the model is based on the feedback from various sources, including: members of the project group, staff and students from the Academy of Shaped Design, the representative of the Swedish Association of the Visually Impaired, and the museum staff at Lödöse Museum.

5.3 Combination of the models

A first evaluation of the combined audiovisual and tactile model by external groups will be carried out in connection with its installation at Lödöse Museum. About 2-3 pilot classes will be invited from schools nearby the museum and from the visually impaired community. The evaluation will be based on video filming of the pilot classes to study how the people move around the model, how they explore the tactile properties of the model, and to monitor their reactions. In addition, half structured interviews with visitors will be carried out to study how the model is perceived in general, how the information mediation works, how the audio track is working together with animation and the tactile model, what the positive and negative impressions are and what to improve.
The model will be revised after evaluation of the comments from the pilot classes. The model will subsequently be presented to the public as an official part of the ongoing exhibition “Images of our ancestors” and will be used for educational purposes.

In the public part of the evaluation, both the model itself and communication aspects are to be studied. This evaluation focuses on external peoples’ viewpoints, i.e. persons who have not been involved in the modeling work. The evaluation will be based on an internet survey, using tools provided by SurveyMonkey.com. The internet based questionnaire survey will be available at Lödöse Museum. Another opportunity to gain feedback from the public is via the web forum of the project, http://forum.time-travels.org. This forum can also be used by web domain visitors to comment on the audiovisual part of the model. Finally, everyone involved with the design and production of the model will be interviewed to reflect on the overall process.

6. CONCLUSION

A first version of the digital model was installed at Lödöse Museum at the end of 2007 (Figure 1) and made available on the internet domain of the Digital Time Travels project (www.time-travels.org/stud1_2.html). In November 2008 the combined model will be inaugurated at Lödöse Museum (Figure 7) and an evaluation of the visitors’ perception of the model initiated. The tactile model is almost finished and the digital model is gradually elaborated. The feedback process is ongoing.

Figure 7: Exhibition hall at Lödöse museum where the model will be placed in addition to the ongoing exhibition “Images of our ancestors”. Photo: Per Stenborg

The formative feedback from all partners has been very valuable. It is an important part of the research process and influences the results to a large extent. This feedback process will be continued. Even after presenting the model to the public, development of the model will continue. Thus, the first model is a basic version which will be improved and extended step by step, e.g., by adding new themes to the animation.

The model utilizes both audiovisual and tactile information to illustrate the historical development of the region, having visually impaired people and young students as two particular target groups. Results from the study will improve our knowledge about the applicability and effect of digital

applications as instruments for mediation and communication in archaeology and cultural heritage management.

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