CARTOGRAPHY AS EFFECTIVE AND SUSTAINABLE ACCESS TO CULTURAL TOPICS

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ABSTRACT
Many aspects of cultural topics are related to space and may be better understood by using appropriate presentation techniques in this context. For the view of cartography, there is the hypothesis that the research of, and communication among experts in art, history and archaeology may be better supported with the power and tools of Internet-, multimedia- and three dimensional cartography.
At the present state the digitalisation, recording and database creation of cultural objects and landscapes is an ongoing process using different methods. The main results, according to a first step of modelling, are high detailed reconstructions used for presentation and scientific discussion. In this communicational aspect cartography may offer a spatial-related overview and multilingual access to masses of digital data with the help of visual classification and usage of user-adapted metaphors.
The considerations in this paper about a cartographic toolbox offering access to and management of cultural topics are based upon the interplay of data access, effective communication and sustainable information availability.

INTRODUCTION
One main potency of cartography is its provision of spatial-based knowledge and support of a regional spanning overview. In context with understanding and dissemination of particular growing, spatial-related knowledge the usage of different human sensual modes and inveterate perceptive environments empowers almost direct knowledge transfers from expert groups to a general public. For the autor’s understanding inveterate perceptive environments name the familiar spatial perception, including its psychological processing methods, developed throughout the growth of a human being. In addition alternate data structuring and accessing methods for a increasing number of data seem to be created and envision immersive knowledge extraction in virtual data worlds.
From this point of view cartography with all its semantic, semiotic and pragmatic rules within the cartographic communication concept may serve as gateway to virtual data-structures and matrices, their captured content and the knowledge transmission of this topology, virtual topography and data access. Having this fiction of mapping virtual data worlds in mind, it becomes clear that the role of cartography may be expanded from the transmission of spatial-related information with different communication techniques to an alternate graphical, and thus multilingual, way of accessing virtual data worlds and explorable topologies.
Beside the communication aspect, where a knowledge transfer and acquisition seems to be the main focus, and data access, where an almost impenetrable amount of data is structured and mapped, sustainable data availability should be mentioned for the work in cultural topics and the field of Cultural Heritage. Until today the printed medium and its traditional distribution on paper seems to be the most appropriate way to transport information and also spatial-related knowledge through time. Of course this method contains all the disadvantages of an analogue medium, which lacks of interactivity, multimedia support or rapid update rates. As a result of sustainability – the transport of spatial-based knowledge through time – in context with effective information transfer – the use of multimedia techniques – there is a need for a transformation ability of presentation forms using the same content. A possible solution may be found in “X-media” (cross-media), which describes the usage of one single content on different media, layouts and presentation forms.
Within the work of cultural related topics and Cultural Heritage the three preceeding topics of knowledge communication, multilingual data access and data sustainability seem to be essential. All of them can be supported by cartographic processing methods as long as a spatial relation seems to be helpful. The following considerations try to employ cartography for cultural topics in context with data access, knowledge transmission and sustainability of historical, spatial-related knowledge.
DATA PROCESSING AND DISSEMINATION OF CULTURAL TOPICS

The work and efforts made in field of cultural topics and World Heritage management result in ongoing processes that are supported by traditional and new techniques in information recording, processing and communication. In general these processes may be classified to three stages that include a discovery-, reconstruction- and dissemination phase [OBP04].

The discovery phase covers the collection, recording and excavation of data. Usable techniques reach from descriptions and field sketches on paper to photographs and three dimensional laser scanning. Each of these acquisition methods differ in some influence of expert interpretation during processing, the presumed technical environment and subsequent steps of archival storage methods. In many cases “data” run through all three stages of heritage knowledge processing, which results in dissemination and communication of new knowledge. But often the discovery phase is the only one. Then collected data have to be stored for some work later on. Thus the importance of discovery phase lies in the collection and sustainable backup of data, which become historical from the moment of acquisition. For instance a rapid excavation is done before constructional changes are made in that specific area. These changes, destruction of old historical structures by creation of a new building in that place, generally lead to loss of data, particularly without scientific recording.

The improvement of digitisation techniques in the last decade and its development in quality allows a more exhaustive recording of a subject. The work with a digital camera is not limited by running costs for material and shows its results rapidly, which enables confirmation of subject documentation in-situ. Misleading pictures may be deleted and storage space for more appropriate data freed. In addition this digital discovery offers a workflow where actual pictures are stored in a database, compared with preceding documentations and distributed within a community. In spite of all efforts it is interesting that a strong resistance amongst archaeologists in adapting these new technologies is observable [LOP03]. It seems that digital processes and results cannot offer deep advantages over traditional methods in recording a site using photography and illustration at the moment. One main argument may be a sustainable access to original datasets, which form the fundament of scientific results. Changes and completion in datasets or different interpretations can lead to variations of these results. Thus the originating data material is crucial for an objective judgement. A worst-case scenario for an archaeologist e.g. represents the destruction of a long lasting work (for decades or even centuries) by one broken CD-Rom or harddisk.

The reconstruction phase spans the usage of discovered data for rebuilding of facts, processes and buildings. It is a subjective process, which outcome depends on the expert and his personal knowledge. Differences of reconstructions due to different knowledge bases of experts are often observable during archaeological work or in following dissemination phase. The reconstructing of architecture and thus rebuilding the 3rd dimension on basis of indications leads to various results. Digital improvements in technology aim to support this construction process, which can be time consuming [MTL03], expensive and labour intensive [STO03]. Thus it should be possible to iteratively generate virtual 3D models from existing fragments, complete virtual models, directly compare the result with others in a database and to classify the artefact. In addition cartographic interpretation tools may help to compare and add spatial dependencies that could help within the reconstruction process. For instance when rebuilding an ancient house in urban environment, directional, topographical or neighbourhood dependencies will generally influence the shape and direction of that building (due to the view of place, architectural affectations, static or technical dependencies).

The dissemination phase contains the distribution and communication of gathered knowledge during discovery and reconstruction phase. It forms a base for discussions in expert communities as well as for educational circulation in a general public.

The expert or professional community makes use of web-interfaces and web databases to access knowledge collections through the Internet [SSE03]. Many projects include URL’s, where their results may be obtained or they involve design of web-interface and databases to make collections accessible [FER03]. As well online catalogues and databases may serve as addition to traditional publications (books), where the online accessible collections contain the reconstruction/interpretation of a theme including illustrations and catalogue text. In general these two parts cover two thirds of all the content in archaeological publications [HARL03]. Furthermore illustrations and graphics utilise maps, which can be online and interactive, to visualise and intensify spatial relations in the specific archaeological/historic context. Even a craven use in archaeology and cultural topics shows the potential and usefulness of maps. Much more power for the communication of these spatial and time
related data can be expected with the help of pervasive cartography and immersive user interfaces. Pervasive cartography brings interactive and multimedia maps into the fieldwork, where it may help in ongoing work. A higher immersion for the communication of cultural heritage content in context with spatial relation may be useful for the dissemination process in a general public too. In these user groups professional and scientific implementations are less important. Many customers of museums, exhibitions and heritage establishments are demanding for “edutainment”, a mixture of education and entertainment. The visitors become increasingly discerning in their evaluations of attractions and due to globalisation they may compare and judge across continents and sectors [FER03]. Events or activities are often not valued for thematics or content, but for their grade of attraction. This fact arises the question for the need of high quality in educational presentations, which seems not to be that important. Assuming that computer-based reality games hold a high grade of attraction (judged by their business volume), it opens expectations that cartography expanded to multimedia and 3rd dimension with immersive user interfaces for knowledge transfer – or better – for attractive presentations may provide high-quality “edutainment” by virtue of existing spatial dependencies, information clustering methods and user adaptation.

Preceding considerations show that digital technologies result in a more exhaustive discovering and documentation phase, support the flexibility and cost effectiveness of reconstruction phase and form a helpful component in professional and public communication processes. Cartography, its task to use and communicate spatial relations and information generalisation, represents an interesting and expectant supplement to all three phases in cultural management workflow. One thing to be noticed is an enormous increase of data on account of low cost, high quality recording methods. This data growth uses digital storage solutions and their ongoing development to overcome shortages in storage capacities. Instead of shortages in capacity, a more problematic situation exists in data extraction and data location/finding.

DATA LOCATION AND VISUAL DATA ACCESS VISIONS

For the understanding of human beings the ordering of bits and bytes is an abstract presentation of values describing objects. These “data” and their topology represent environmental semantics, which had to be transformed to a mechanical language – the one of storage disks and computers. But this representation seems not very appropriate to find some “writings, paintings” or objects in a human sense. Following these thoughts of obscure masses of bits and bytes, a storage disk today consists of bits&bytes in machine language and thousands of words in form of file-names for the human user of the computer. The large amount of files makes it almost impossible to find some content. So it comes up that “search-engines” or “meta-data” readers are useful tools to extract some information in acceptable time periods. Furthermore it turns out that a visual access using data semantics and topology may be useful, because this uses sensual depth cues humans are used to and is independent from spoken language due to graphics. Therefore it is strongly connected to its form of mapping – its use of the presentation metaphor.

The creation of visual data access is almost independent from the data content or an application domain. The framework and mapping strategy uses visual metaphors and semiotics. It incorporates the meaning of data and existing dependencies for an effective data characterisation and visual metaphor usage. Three steps characterize the composition of a distributed object framework that is used for mapping a virtual data world [SAN00].

The first step gathers the raw data and metadata from monitored sources and databases, thus it is called collection layer. Secondly, the structuring layer structures the raw information according to the service being monitored. The presentation layer uses an appropriate chosen metaphor and maps the structured information onto graphical components with the help of adaptors. Adaptors are responsible for information mapping between the structured data coming from structuring layer and the visual components of the virtual world.

The role of metaphoric mapping is based on the understanding of the user. The usage of an environment that is similar to the surrounding of everyday’s life including meanings and interconnections, seems to make the presentation more effective. Thus from a general viewpoint the choice of a metaphor may be done on behalf of two criteria within the mapping process: effectiveness and expressiveness.

Effectiveness regards aesthetic concerns as well as perceptual information acquisition, immersive interface use, optimisation processes for data simplification and visual rendering improvements.

Expressiveness refers to visualisation capacity of the metaphor and interface, which concerns the semiotic question of representing all collected information. Is it possible to represent all the information with the “few”
communication parameters the metaphor and interface offers? For instance, if the number of communication parameters in the metaphor for transmitting the information is fewer than the number of desired data values, the metaphor will not meet the expressiveness criterion. Further on, if the metaphor meets the criterion of expressiveness, there is the question left, whether the interface (screen, paper, HMD) can meet the criterion. Only if the number of communication parameters in the metaphor as well as the interface is sufficient to carry the number of data values, the desired univocal relationship gets established [MAC86]. Mapping more data values onto one single communication parameter makes a determination impossible. On the other hand, communication parameters may be unused as long as there is no need for them to be utilized.

Communication parameters cover all elements that are used for information transfer and serve human sensual modes. As an example the use of a city metaphor in a 3D data world visualises data in form of street networks, districts, blocks of buildings, houses, floors, windows and every element that could easily be connected to a city (bridge, green, ...). A 3D application with the city metaphor assumes the use of a 3D presentation interface, at least some Pseudo3D interface, that is able to transfer all the modelled parameters to a user. A high immersive transmission and presentation of data with a Real3D interface would establish the most familiar – realistic – environment with all freedoms of movement and perception.

The mapping of information requires some data characterisation. With the aim to be applicable to various application domains, the data characterisation should be kept as general as possible, like in the project CyberNET by the EuroCom Institute, France [ABE00]. In there three principal dimensions are mentioned: type, time and semantics, where the type dimension is splitted to quantitative information, defined by scalar values, and qualitative information, that consists of nominal values (unordered set of nomination) and ordinal values (ordered set). Because most data are highly time-dependent, one focus is on the time dimension. Also, the semantic dimension shows its importance with the specification of semantic context. It specifies the usage of the data characterisation in a spatial service (e.g. a “size of disk” is used by workstation monitoring service).

The data characterisation to type, time and semantic seems to be applicable in cultural and world heritage issues. One important characteristic should be added: geographical space or position. Alike the high dependency on time, most historical remainings, developments and processes do have a spatial relation. Thus this characteristic field of “space” or “space-time relation” should be used in a metaphoric access to the virtual data world of heritage. Occurring problems in providing an understandable and perceptive ascertainable presentation notably address expressiveness and effectiveness.

**CARTOGRAPHIC COMMUNICATION SUPPORT**

Cartographic methods concern expressiveness, effectiveness based on perception or/and cognitive processes and knowledge acquisition supported by data structuring in mental maps. The main task of transporting spatial-related information and knowledge from one person/group to another includes considerations of human and technical perceptual bandwidth, applicable information depth and transformation to knowledge.

During the steps of cartographic modelling, geographical and spatial-related data are transformed from the primary data model, a container or database for the management and analysis of acquired information, to a secondary model [KEL02], which focuses on the technical and perceptual capability of the interface and thus the depth of information, usable semiotic, bandwidth of modality and coding mechanisms for information. A wide range of usable interfaces for the geographic communication demands for various processing steps or a distinct intensive application of these. Mostly the intensity of this generalisation depends on the resolution and size of the interface. A display for digital use may offer a size of about 30 x 40 cm and a resolution of 72 or 96 dots per inch (depending on PC or Mac). All information coded to graphics on this screen underlie these parameters. Thus a minimum size for points, lines and areas may be fixed to ensure perceptual availability of information, which means that the information can be read and recognised. In contrast to a medium of paper, which has almost no restriction in size and a resolution of about 200 lines per cm, a display for digital use makes additional modalities for information communication accessible. Multi-modality, different media combination and interactivity offer some reduction of the display’s technical restrictions and could be subsumed as “multimedia”.

A paper medium and a screen may communicate the same information elements. But to follow the expressiveness criterion a various intensive generalisation or different rules of cartographic modelling have to be applied. As a result the transformation from the primary data model to the secondary data model takes account of the technical capability, graphical resolution and visible size of the resulting interface.
The technical moulding of an interface may support different perceptual and cognitive parameters of the human sensory system, resulting in an adaptive information presentation. Focusing on the visual sensory system, the immersion of communication process will increase with support of visual depth cues and provide the user with a familiar environment of perception. The factor of immersion is strongly connected to the parameters of visual perception. The definition “…a psychological state characterised by perceiving oneself to be enveloped by, included in, and interacting with an environment…” [WIT98] assumes the existence of psychological and physiological parameters for spatial perception. The more parameters – depth cues – are used by a visual user interface, the more a user will be immersed into the virtual environment.

The parameters for the visual perception of depth in space are classified in physiological and psychological terms. The physiological parameters describe the technique of the human visual system and include retinal parallax, accommodation, convergence and the parallax of movement. The psychological class is independent from the technical condition, supporting relations between the real and perceived world and strengthens the spatial impression. It consists of the size of the retinal picture, linear-perspective, air-perspective, overlay and hiding, shading and gradients of texture. [ALB97] These human factors, the theory of spatial perception, physical parameters of the display and graphical semiotic form a basic classification of visual presentation: “pseudo3D”, “p3D” and “real3D”.

Most computer-based 3D applications use the pseudo3D form. A two dimensional surface visualises the presentation of a three dimensional application. Here, apart from a screen, no additional hardware is needed. Pseudo 3D provides perspective monoscopic visualisations on flat devices – paper or screen – and only uses psychological depth cues.

P3D stands for “Parallax 3D”, which employs selected bi- and monocular physiological and psychological depth cues. It mainly includes the technologies of chromostereoscopy, Pulfrich effect, stereoscopy and multistereoscopy (e.g. lenticular lenses on a paper medium). In most cases additions to the screen are needed to enable P3D (e.g. shutter glasses).

Real 3D presentations use all available bi- and monocular physiological and psychological depth cues. Within these images of space, continuous effects of parallax occur in all directions. The main technologies for production of these images are volumetric imaging, light emitting volume, rotating helix mirror and processes of holography [SCHRATT05].

The technical possibilities of the interface, its supply of human sensual modes and depth cues seem to be the main important factors of effectiveness in spatial information transmission from a strict technical point of view. Both aspects, effectiveness and expressiveness, are responsible for the human perception of presented information. A further processing, utilisation of perceived data and possible knowledge acquisition follows with data structuring and creation of a mental model.

The assimilation of information within a multimedia 3D environment does not only depend on depth cues but also on processes of memorising and learning. Therefore a 3D environment may be a helpful tool when thinking about active knowledge acquisition.

Following the principle of Zimbardo [ZIM95], knowledge acquisition is supported by the grouping of information and the usage of individual rules of organisation and order. In cartographic tasks this means that criteria for similarities of body structure and temporal behaviour, common meaning and organisational structures according to semantic classification and hierarchical structuring are being made [BUZ00].

In addition the learning theory of Bandura reverts to a dual coding. It says that the establishing of knowledge is based upon learning of direct experience and representative experience. Therefore imitating and evaluating sequences of imitation [BAN87].

The construction of patterns and the adoption of categorical behaviours is activated by processes of enhancement and motivation, which may be evoked by the usage of different modalities of the same information – e.g. changing of colour and sound to express one information [DRA97]. With the help of individual memory-structures, changing knowledge of an environment is a process of building, storing and realisation (essentially as patterns). New experiences, interactions and situational activities change stored knowledge and reshape it. Perception and knowledge acquisition is a continuous activity that may be depicted as cycle of perception [NEI79].

The enhanced knowledge acquisition, the influence of a “cartographic” presentation and its spatial related content on knowledge processing, seems to strengthen and support dissemination of specified topics. A distribution of this kind causes an actual creation of consciousness towards the presented, spatial related theme, which may deal as basis for individual stories, personal remembrance or a sustainable recall of experience connected to this topic.
For all these considerations the acquired knowledge stays individual and cannot be copied to other individuals. Thus its sustainability is strongly linked with the individual. A general sustainable access to spatial-related data and its expressive as well as effective presentation method calls for further investigations on methods for transmission of these techniques during time.

THE DILEMMA OF SUSTAINABILITY

Asking for a sustainable communication methodology calls for a definition of “sustainable”. According to the definition of the Brundland Commission (World Commission on Environment and Development, Our Common Future, Oxford University Press, 1987) it is defined as: “to meet the needs of the present without compromising the ability of future generations to meet their own needs”. The author’s understanding of this definition, in context with cultural heritage and the work of cartography, means that the original natural and cultural objects on one hand and models, recorded data, cartographic communication models and applications as well as spatial connected knowledge – including maps for reconstruction and cartographic interpretations of real objects – on the other hand should be “archivable” and usable for future generations.

From this point of view photogrammetric and geodetic models require open data standards. It can be expected that proprietary formats will not be readable in near future [http://www.rlg.org]. For the cartography point of view, the knowledge presented with the help of maps and cartographic applications should be available in the future. In addition to seminal programming standards of applications, maps need to be readable and understandable, independent from its semiotics and preliminary knowledge.

The dilemma of sustainability in cartographic communication mainly roots to the different support of multimedia. Traditional maps on paper-based media do not support multimedia components like interactivity or multimodality. The transmission of spatial-based knowledge is restricted to few modalities and assumes preliminary knowledge in map reading. A user requires a specific knowledge basis to make use of this media for knowledge acquisition. Computer-based interfaces may offer the whole range of multimedia support and immersive environments. Depending on the grade of immersion a familiar environment can be established for the communication process. In general a user employs basic behaviour of movement and knowledge acquisition.

Various historic examples show that paper-based or similar (papyrus, stone) media can be transferred through time sufficiently. Of course time leaves some remaining of use or influence of light, but generally the content is perceivable and often also readable, if the used semiotic is known. In contrast computer-based media present their content only, if the media is not damaged and can be connected to a working computer (or read with an appropriate device), the formatting of the media is readable, the format of content/data is supported and requirements for file execution are fulfilled. The access to a CD, DVD or harddrive in 100 years from now is highly disputable on account of this amount of influencing parameters.

A possible solution for a sustainable access to spatial-related datasets can be seen with the technique of migration: Worth while datasets need to be copied to the latest media in redundant form (to overcome media damages). In addition the information entities of datasets should be diverse, which means that digital entities should cover any available computer platform and non-digital information entities should be created [BOR03]. First concepts and considerations in this direction are made and subsumed in the notion “cross-media”. It describes the technique of using the same content on different media. Beside a various intense implementation of generalisation methods due to the different characteristics of media, problems in transforming multimedia contents to different media are obvious.

CONCLUSION

The cartographic communication process, from data acquisition and structuring to the creation of cartographic models depending on the capability of interfaces and influence on the mental model of the user, follows a directive that may be found in the workflow of heritage topics as well as alternate data access methodologies. Strong analogies on one hand and benefits on the other hand are delivered from cartographic model creation. Analogies cover the similarity of workflow which goes from data discovery and gathering to reconstruction and structuring until it reaches presentation and dissemination techniques. Benefits from cartographic communication influence the focus and regards to different characteristics of media, their resolution, size and ability of immersion creation, and adaptations to user behaviour and their knowledge acquisition. It seems to be obvious that perceivable information in combination with immersive computer-to-human interfaces are more effective for accessing cultural topics and spatial-related data than machine (computer) based semiotics and visible topologies that do neither meet the criterion of effectiveness nor expressiveness.
The question of sustainability of data modelled for cartographic communication ends up in the dilemma of transience of digital media. High communicative presentations need computer-based applications and interfaces that have a very limited lifetime. In opposite traditional media, which cannot offer multimedia support, are known to overcome decades, centuries and even millenniums. Recent developments for cartographic cross-media production possibly result in a solution for these problems. At least an applicable methodology for communicating spatial-related information with similar effectiveness on different media would enable the strategy of migration and thus provide a way to preserve specific spatial-related datasets of the world heritage.

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BIOGRAPHY

Markus Jobst, born 1972, studied surveyed at the Vienna University of Technology and finished his MSc in 2003 with the focus on usage of multimedia technologies in 3D maps. He is research assistant at the Institute of Geoinformation and Cartography since 2003.
Beside his commercial cartographic and multimedia-cartographic activities and the coordination of the scientific projects for photogrammetric documenting Roman epigraphs at the museum Carnuntinum / Bad Deutsch Altenburg (1996-2001), Markus Jobst acquired substantiated knowledge in digital photography and cross-media production processes.

His main foci in scientific work are in communication of spatial related data, multimedial 3D cartography and digital cartographic presentation methods including cross-media publishing.