12 *Atlas of Switzerland 2* - A highly interactive thematic national atlas

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12.1 Introduction

The *Atlas of Switzerland* (*AoS*) is now a well-established cartographic product and a national brand with a wide variety of usages and applications. The second edition of the interactive *Atlas of Switzerland 2* (*AoS*) plays a prominent role in national diffusion of spatial knowledge. The atlas is based on concepts propagating adaptive maps and interactive tools in a multimedia environment. The framework also considers a graphical user interface concept and the integration of 2D and 3D maps.

An overview of the thematic *Atlas of Switzerland 2* gives insight into project management and editorial work. Furthermore, it demonstrates the realisation of the conceptual ideas and the basics of technical implementation. The features of *Atlas of Switzerland 2* are discussed in detail, placing emphasis in the 2D part on adaptive maps, the interactive tool kit and the topics. In the 3D part, visualization, analysis and navigation features are of concern.

Looking at future atlas development, the potential of interactive atlases is, even ten years after beginning, still very high.

The range of application includes schools and universities, where the *AoS* is frequently utilised for educational purposes, for teaching cartography and even architecture. Private individuals use the *AoS* as an information centre (visualization and analysis of census data, terrain features, mountains, etc.), as a planning tool for hiking tours, and for illustration purposes. More technical applications of the *AoS* in industry can be found in mobile communication, transportation industry and water management. With its 2D maps and 3D panoramic views, the *AoS* serves as well for technical, informative illustrations in various magazines and newspapers. 3D terrain visualizations were even used for a game (‘Tour of Switzerland’ by Carlit) and for political and product advertisement (voting for a new sports stadium, ads for public transport). Since the first prototypes of Edition 1 in the late nineties, the *AoS* has often been a substantial part of public exhibitions: 'Eiszeit – Zeit für Eis' 2004, 'Maps of Paradise' at the Swiss Embassy in London 2004, 'Mapping Switzerland' 2005, '150 Years ETH Zurich' 2005, to mention just the most recent instances.

The *AoS* initiated and supported several derivative products, e.g., a point of interest station at the *Bergführermuseum St. Niklaus 2000*, the CD-ROM series *Statistical Atlas of Switzerland* (Swiss Federal Statistical Office SFSO 2003ff), and a CD-ROM *Political Atlas of Switzerland* (SFSO 2004). Based on edition 2 of the *AoS*, a CD-ROM *Audio-Visual Linguistic Atlas of Switzerland* (University of Berne 2005) and the *Statistical Atlas of Switzerland* on CD-ROM (SFSO 2006) are actually planned.

For its GUI and cartographic design as well as for the categories of interactive functionality and didactic capabilities, the *Atlas of Switzerland* has won several national and international prizes.

12.2 Brief history of the *Atlas of Switzerland*

The *Atlas of Switzerland* is really a success story. Since its start in 2000, more than 20,000 copies have been distributed. While the first edition was sold 14,000 copies, the second edition reached 6000 copies within the first year of publication.

The first digital edition, the *Atlas of Switzerland – interactive* (2000) was conceived with the following characteristics and principles:

- CD-ROM in four languages (German, French, Italian, English) for Mac and PC;
- Run-time edition with plug & play;
- Graphically and cartographically well designed product;
- 250 highly interactive statistical topics and a 3D part with panoramic views and block diagram representations;
- Basic tools for map and terrain visualization and explorative analysis; and
- Time-line for temporal map analysis.

The second interactive edition, the *Atlas of Switzerland 2* (2004), has undergone in an evolutionary sense a fundamental graphical and technical redesign (fig. 1). In addition to the first edition, it contains the following main features:

- CD-ROM and DVD edition;

- More than 1000 map topics. Update of the 250 statistical topics, adding another 100 statistical topics, and 650 topics from the field of ‘Nature and Environment’;
- 2D section. New map types (raster and symbol maps, etc.), advanced analytical tools (comparison), amplified base map and geographic information;
- 3D section. Smart navigation tools (‘climber’, etc.), multiple layer overlay, advanced visualization modules (analytic, cartographic, photorealistic);
- Multimedia elements. 600 text panels, hundreds of pictures, sound and video;
- Visualization attribute export to store the map setting; and
- Image export and printing.

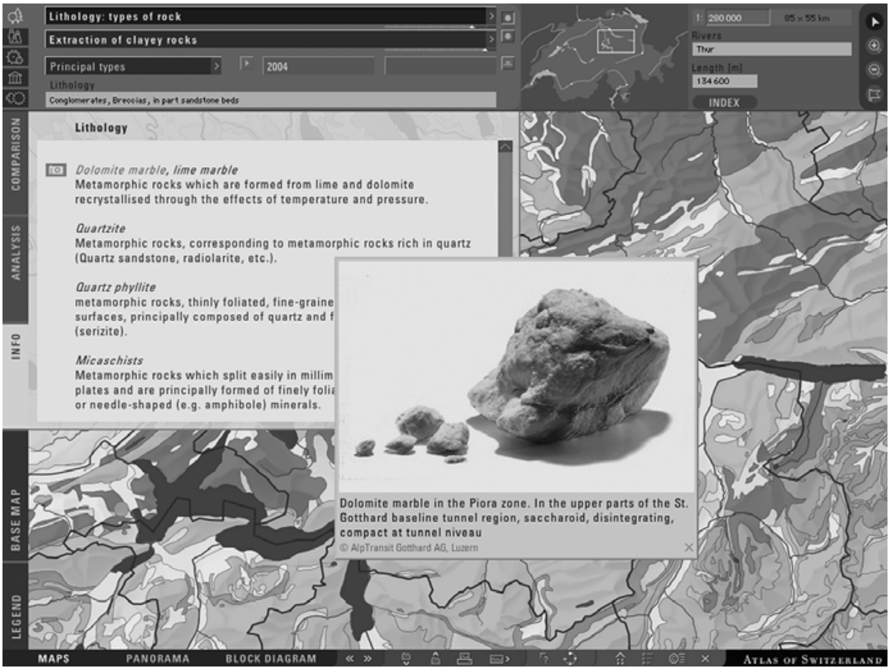

Fig. 1. Graphical User Interface ‘Atlas of Switzerland 2’ 2D part with information panel.

How was this achieved and managed? First of all, a ‘user-centered’ vision was followed, keeping the ‘useful’ visualizations and interactions at the centre of thinking, designing and programming. In contrast, many other interactive atlases and maps on the Web often use a technical driven approach, resulting in Geographic Information Systems (GIS) - like tools people do not understand.

The second item of success is ‘quality’. Quality has to be understood not only in a cartographic sense, but also as overall graphic quality, thematic consistency and depth, and even as quality in technical design and implementation.

To fulfill these demands, it needed, as well as funding and a winning team, much time and patience!

12.3 Basic concepts and other thoughts

The basic idea of the *Atlas of Switzerland* is communicated best with the metaphor of the atlas as a ‘story book’. It should present a framework that users get familiar within a few moments. The atlas ought to make them feel comfortable – whether they are laymen or experts eager to be immersed into the stories, to take a journey without getting lost in space (serendipity effect). On these journeys the map is always the starting point for investigation and provides the main metaphor; it acts as an anchor. But the map also represents the completed product and the result of the investigation is always shown cartographically. Then, with sophisticated maps and easy-to-use tools to explore the thematic and topographic Swiss world in 2D and 3D, the atlas can fulfill not only user curiosity, but also meet their demands.

To realise these main objectives, various concepts and approaches have been elaborated upon during the last ten years of atlas work. In the following sections we provide a short overview of atlas considerations.

12.3.1 GIS in Multimedia

Dealing with interactive atlas applications, there are basically two methodological approaches: ‘Multimedia in GIS’ and ‘GIS in Multimedia’ (Craglia and Raper 1995). While ‘Multimedia in GIS’ means that atlases run in a GIS environment adding multimedia functionality, the ‘GIS in Multimedia’ approach is based upon an authoring system; navigational and analytical functionality have to be added.

The ‘story book’ idea of the *Atlas of Switzerland* strictly calls for the ‘GIS in Multimedia’ approach. Choosing this concept implies time-consuming programming of all interactive map functionality by the atlas authors. A big advantage is that navigational, visual and analytical functions are assembled and assimilated according to the atlas users’ needs.

Now, powerful digital atlases should not only be able to analyse, process, and model multi-dimensional and spatio-temporal data, they should also focus on excellent graphics and high cartographic quality (Bär and Sieber 1999). Therefore, any geometry data, in vector and raster format, for the *AoS* undergo a cartographic refinement process. As a result, the visualization of the map elements can run in an intelligent way and accord to sound cartographic principles.

12.3.2 Adaptive Map

Interactive maps and 3D representations in a 'GIS in Multimedia Cartography' environment require an intelligent organisation and visualization of map graphics and a flexible connection with the attribute data. The 'Intelligent Map' concept (Hurni, Bär and Sieber 1999) follows these principles. In the meantime, it has been constantly refined, and its focus shifted to adaptive techniques. Focussing on interactive atlas maps, we therefore propose a new concept - 'Adaptive Map'. The Adaptive Map concept is realised by means of self-acting, pre-defined settings and interactive processes. The ingredients are numerous, ranging from layer management and self-acting adaptive zooming to cartographic quality aspects.

Adaptive zooming can be described as continuous and smooth zooming, always maintaining the same map element density and providing more detailed information when zooming in. For the *Atlas of Switzerland* this means that all base map layers need to be available in two map scales, and within one map scale up to three density levels. Furthermore, zoom-in makes thematic point symbols enlarge more slowly than the overall map zoom factor, leading to less symbol concentration in otherwise crowded map areas.

Layer management also deals with the concept of 'active/passive' layers, letting the users steer the activity mode of the layers, and also with 'hidden' layers. In the latter case, thematic layers do not appear in the main menu, but can be visualised as an associated second map layer. Thematic or topographical information may be accessed by means of underlying assistant 'invisible' layers, thus providing a comprehensive query system. Regarding queries, the concept provides the foundations for multiple simultaneous queries.

Cartographic quality in an adaptive map is a combination of self-acting, pre-defined settings and interactive processes. Layer consistency, screen-adapted symbolisation methods and anti-aliasing are prerequisites, while other parameters of visualization (e.g., transparency and colour gradients) could be altered in an ancillary way by the users.

All-in-all, the ‘Adaptive Map’ concept fits for any map type (vector and raster maps, 2D and 3D maps) and thus for heterogeneous layer, but it works with an almost overall homogeneous functionality. The ‘Adaptive Map’ concept provides one of the prerequisites for a fully interactive atlas. To deal with such adaptive maps, a tool kit with interactive functions for visualizatio , navigation and analysis has to be provided, as well as a consistent but flexible GUI.

12.3.3 Graphical User Interface

The Graphical User Interface (GUI) plays an important role in information acquisition and in transforming this information into useful knowledge. In an atlas, *information access* can be achieved in many different ways, but is most efficiently done via maps, topics, multimedia, didactics, or even language.

Since an atlas is understood as a formal compilation of maps, the map should always dominate the GUI. This requires an appropriate *segmentation* of the screen surface, a strict *modularisation* of the GUI elements, neat *interaction* possibilities between GUI elements, and high *consistency* of content, graphics, actions and feedback.

Segmentation is merely accomplished in a functional sense. According to the basic conceptual framework, five main functionality groups can be distinguished: Thematic navigation, spatial navigation, visualization, analysis and general atlas functions (print, export, etc.). These groups are implemented in the *AoS2* as corresponding atlas segments. For example, the spatial navigation segment includes a reference map, displays coordinates, height, directions etc., and provides indexes of map elements, pins and other orientation tools (fig. 2).

Modularisation means that the GUI is organised in a shell/content manner (Huber, Jeller and Ruegsegger 2005). The shell of the atlas consists of a variety of independent but linked modules, while its content is treated separately.

GUI interaction can be subdivided into internal and external facets. The atlas should allow for dynamic adaptation of the GUI to different screen sizes, considering any standard formats. The *AoS2* is designed for screens with 1024 x 768 pixels or higher. Another internal interaction category is about decisions whether, when and in what way to close windows or panels when overlapping. External interactions can be subsumed under the keyword ‘feedback’. Every action of the user has to be followed by an immediate reaction of the system (wait cursor, different status of buttons - active/inactive, etc.). In an atlas, this feedback should be given whenever possible in a cartographic way, for example by using the map to visualise search results, or the map preview for navigation and orientation.

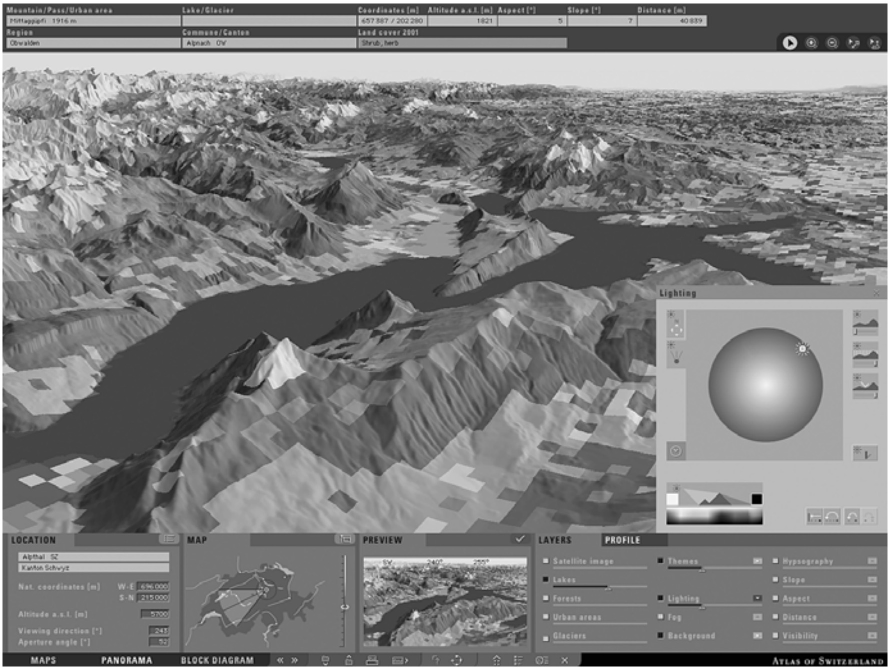

Fig. 2. Graphical User Interface 'Atlas of Switzerland 2' 3D part, panoramic view.

GUI graphics are the essential link to the user. The 'look and feel' should be both pleasing and unique. We propagate an unobtrusive overall design, clearly distinguishable from other applications and from the map itself. GUI fonts and icons should be easily readable, and colours have to be discreet. In the *AoS*2, the dark blue colour communicates a sophisticated product with reliable, interesting information.

Consistency affects nearly every facet of the atlas GUI, whether it is thematic content, tools, graphics, actions or feedback. A crucial point is the consistency between functionality and usability (what does the user expect?). In an atlas with 2D and 3D maps, the consistency between the map modes is also a concern.

12.3.4 3DThinking

The *Atlas of Switzerland* integrates 2D maps and 3D maps (Huber and Sieber 2001). In the long run, the gap between 2D and 3D should be closed as 2D maps are only a special case of 3D maps. Most of the navigation and analysis tools could be approached in the same way. Even the user interface might look and act in the same way. Navigation – defined as “the overall process of motion and wayfinding” – becomes a central feature of interaction. 3D navigation can be given or interactive, or, alternatively, discrete or continuous. The concept of ‘3D Thinking’ in interactive atlas navigation results in user-friendly solutions, which allow for a smooth transition between 2D and 3D maps and for easy 3D navigation, with no orientation loss.

As 3D maps have become widespread the concept of visualization methods for 3D (2.5D) surfaces has been developed (Huber, Sieber and Wipf 2003). The visualization module approach is based on independent modules (like aspect, lighting, etc.) that can be combined. First the rendering engine calculates for each pixel the 3D coordinate and the surface normal; secondly for each pixel a colour value with alpha channel – allowing semitransparent colours – has to be determined. A single visualization module like hypsography provides a colour value. The weighted average of the colours of all activated visualization modules is the colour value requested. Visualization methods can be classified on the basis of four criteria: spatial dependency (local vs. global), calculation base (coordinate value, surface normal, etc.), dimension of colour values (constant, dual, 1D, 2D), and optional additional parameters (e.g., point, vector). A visualization method specified by the criteria is a base type. Specified for thematic uses a single base type or a combination of base types builds a visualization module. The visualization module may own specific analysis and visualization tools. The combination of visualization modules is a powerful analysis tool. For example, avalanche risk regions can be modelled using hypsography, aspect, and elevation.

12.4 Organisation and implementation

The *Atlas of Switzerland* is a joint venture by different academic and administrative groups, currently within a ten-year period from 2000 to 2009. This decade of the project is basing on a business plan formulated in the mid-nineties. In the following sections, the *Atlas of Switzerland 2* (*AoS*2) with respect to project organisation, management and workflow is described.

12.4.1 Project organisation

A Steering committee with members from ETH Board, ETH Zurich, swisstopo, and SFSO manages the global project with respect to supervision and financing. The Atlas team ETH Zurich is responsible for project management, software development, GUI implementation, data acquisition, editorial work, cartography, prototyping, mastering, related teaching and research.

An affiliated Atlas group of swisstopo Wabern deals with cartography, multimedia, marketing, product manufacturing and distribution. SFSO Neuchâtel serves as a main statistical data provider, and does the translation of statistical topics.

A small company, Duplex Design, Basel, is responsible for graphic design of the GUI. Over 50 data owners mainly from public administration provide statistical data, geometry and multimedia elements. And finally, more than 20 professional translators are involved in the project.

All these activities between the different contributors are coordinated by the Atlas team ETH Zurich.

12.4.2 Project setup and management

Each project phase of the *Atlas of Switzerland* begins with a two-day *start-up meeting* in a location away from daily business activities. The aim is to discuss long-term objectives and the main focus of the planned atlas edition, new technologies and – last but not least – to build team spirit. The main result of this meeting is a brainstorming list, with future thematic and functional features outlined. The list contains possible new or extended functionality of the atlas edition in a rather unstructured way.

In the next step the project framework is established. It defines the overall structure and the content of the atlas. The functionality is more precisely defined and the wish list is structured in a hierarchical way. The project framework and its content are updated constantly during the prototyping phase.

On a more concrete level, a storyboard with typical applications and scenarios is created, containing sketches of GUI elements and atlas layout. In parallel, technical investigations and definitions concerning multimedia platform, etc. are undertaken. Then, a roadmap with milestones sets the timetable for the project. These steps are of great importance for the whole project because they define the route of the planned atlas. The decisions made at this point should not be altered at a later stage.

After this, editorial work and prototyping takes place. At the same time as the editorial work, technical prototyping is of main concern. As both editorial and technical prototyping take up a big part of the project's time – for example, more than two years for *AoS*2 –, they are described in detail in the following sections. As a matter of course, prototyping is an iterative process, refining all quality categories mentioned in the concept section.

As per team working in parallel, the collaboration of the team members is highly simplified using a version control system both for software development and data handling.

Prototyping is accompanied by testing and after each prototype milestone is met, functional tests or usability tests are conducted. The results of these tests lead to technical and graphical corrections and adjustments. In fact, prototyping and testing complement each other.

In the last six months, the atlas was tested at 'Beta-Version', 'Release Candidate', 'Ready for Publication' and, finally 'Official Publication' with an associated press conference.

12.4.3 Editorial workflow and prototyping

Editorial work is handled in three main phases: familiarisation (with themes, owners, topics and data), refinement (data structuring, cartographic) and implementation (geometrical and numerical data, map descriptions, multimedia elements). First of all, the editorial group has to carry out investigations on themes and topics. Questions about main themes, possible data sources, data quality, data availability, spatial and temporal resolution are addressed. Information is gathered mainly from experts, publications and newspapers. After familiarisation with the potential topics, data owners are contacted. Presenting ideas, maps and sketches is very important to communicate the project's mission, and to get a contract for test data and multimedia features.

Data acquisition includes the definition of the data wanted and the delivery of geometrical and numerical data. Once the data is delivered they have to be controlled and structured. The structuring process includes data harmonisation, data completion (adding missing values and additional information), and data recoding. Geometry data often needs thorough cartographic refinement and always needs preparation for an adaptive map application. At the same time, the potential of the data has to be understood. The authors have to evolve a strategy how the data can be turned into a map that fits into the atlas framework.

Data implementation is done by using XML-based map description files, which fully qualify topics. The ongoing software development does not affect data implementation. Multimedia elements are collected, edited and integrated in the atlas prototype. Whilst textual information has to be at a popular-scientific level, pictures and tables need additional remarks and copyright information added. Most of the text is delivered in only one or two languages. Professional translators acquainted with the topic provide translations. Finally, to get feedback and to develop a well-founded proof of concept model, the editorial team discusses the results with data owners and other experts at different stages of design and production.

12.4.4 Technical implementation

The technical implementation of the *Atlas of Switzerland 2* needs to take into account several prerequisites and guidelines, namely:

- Provide an overall graphical user interface design, which hides the system user interface;
- Use a common operating system (Mac *OS 9* and *X*, *Windows 98* and newer; with five years backward compatibility);
- Work within a multilingual environment;
- Give fully separate 2D and 3D 2D and 3D part of the atlas, as the CD-ROM version contains two disks;
- Offer full screen display with adaptive layout;
- Ensure that editorial staff and software developers work side by side;
- Consider that the development is a highly iterative process; and
- Be prepared for derivative products.

These demand a highly modular software design to achieve extensibility, and reusability. Operating system related differences need to be isolated and minimised. The *AoS*2 is conceptually split into three sections (GUI, core and data); the interfaces between these sections are kept as lean as possible with strictly defined, consistent interdependencies (fig. 3). As derivative products need to be supported, the interface shell is largely separated from the interface content (Huber, Jeller and Ruegsegger 2005). As mentioned earlier, XLM-based files fully qualify topics.

Both 2D and 3D parts of the *AoS*2 work independently but they are linked. The introduction, multimedia information elements and most of the GUI of the main sections have been implemented using the Macromedia *Director* authoring system. *Director* has an open architecture, allows free graphics design, and supports cross-platform development. The *Director* section was written in ‘Lingo’, *Director’s* object oriented scripting language. Shared sections of the 2D and 3D part are placed into independent, so-named, ‘Casts’.

Everything else (the larger part), maps on demand (2D and 3D), more complex widgets (for example, the map legend), all data handling and printing, as well as handling the multilingualism were written in C++ using the software-development tool suite *Metrowerks CodeWarrior* (*Macintosh* and *Windows*). The 2D and 3D sections share much source code organised in a cross-platform framework. For each section, a dynamic C++ library was built. The C++ libraries were added by lean 'Xtras', Macromedia's plug-in interface.

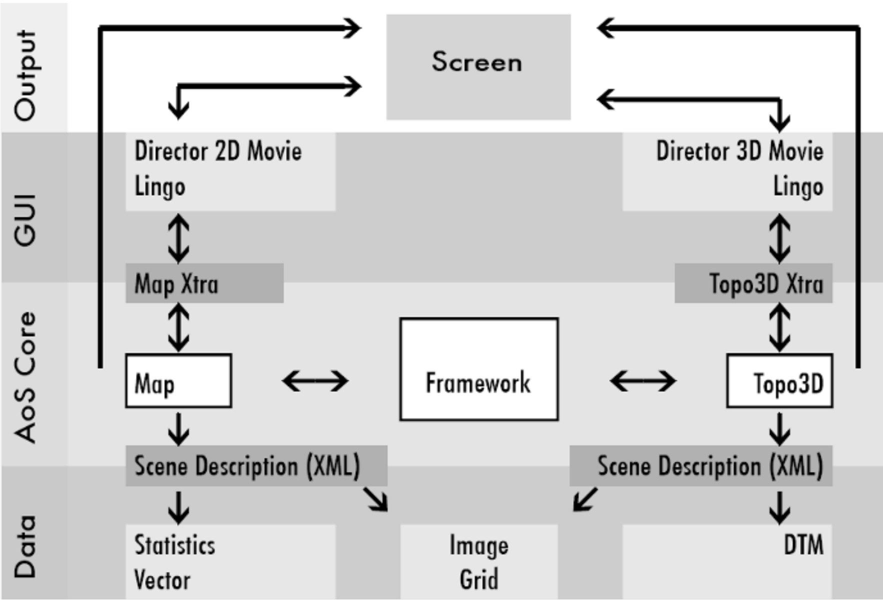

Fig. 3 Modular implementation of 'Atlas of Switzerland 2'.

12.5 The 2D world: maps are beautiful

The 2D map section of the *Atlas of Switzerland 2* (fig. 1) contains maps covering over 1000 topics. In total there are more than 7000 maps. Topics are accompanied by multimedia elements and tools for visualization, navigation and analysis is offered.

12.5.1 The adaptive map

The adaptive map assembles many cartographically prepared, anti-aliased map layers of different types. Two content groups are distinguished - base map layers and thematic layers. Eighteen base map layer groups can be combined in any number of ways, allowing the base map to be adapted to the topic such as cities and villages, lakes and rivers, glaciers, railways, roads, forests, boundaries, mountains and passes, contour lines, relief or satellite image. Up to two potentially active thematic layers (one is active at a time) can be added as well as so-called 'mute' layer, which contains non-interactive graphics. In order to support adaptive zooming, a base map layer group consists of two scales. Within one map scale there can be up to three density levels, for example, the layer 'river' consists of five complementing layers. This is done beginning with the first sub-layer of major rivers at a scale of 1:1,000,000 and accomplishing the full river network with the fifth sub-layer of tiny creeks at 1:500,000.

From a technical point-of-view raster and vector based layers will be defined. Raster based layers are either non-interactive images like satellite imagery and relief, or thematic raster maps (Ruegsegger, Schmid and Sieber 2004). The thematic raster maps can be interactively queried, classified (depending on the level of measurement of the data) and coloured. Vector based base map layers can be queried only. The most important vector based thematic layer types are the choropleth layer and several types of point symbol layers. These can be interactively queried, classified, and coloured as well.

12.5.2 The atlas 'tool kit'

The tool kit includes all tools used to interact with the adaptive map. Different tools handle different visualization, navigation, analysis and query-related tasks, whereas tools may partially combine tasks from different functionality groups. The following summary explains the capabilities of most of the tools in the 2D section, while 'thematic navigation' will be discussed in the section following this.

'Spatial navigation'. The reference map with a resolution of two kilometres per pixel shows the mapped area and this can be altered. The map itself serves as a more accurate navigation tool. There are three modes - pan, zoom-in, and zoom-out. The rectangle selection tool is designed to select the map area to zoom-in. The scale can also be changed numerically.

'Gazetteer'. An index contains a list of names of places or areas relating to the map topic, as well as terms used on the base map. The object moves into the centre of the map by clicking on the name. All these navigation features of the 2D section are only a subset of the 3D navigation features. Visual ‘pins’ store ‘favourite’ positions for later recall.

‘Queries’. Virtually all objects of thematic and base map layers can be queried. The 2D section provides for a thematic map of up to four map-defined fields.

‘Legend’. The legend adapts itself to the map types and shows all thematic map layers. A few maps, like geology, are highly structured, with many levels of information presented, and their legends have to be organised hierarchically. Legends provide the potential for interactivity. The objects of the map that have been already queried are highlighted in the legend and a mouse click in a legend field temporarily converts all the other objects on the map to greyscales, highlighting the objects selected. The base map tool allows a choice of base map layers.

‘Analysis tool’. Individual cartographic representations can be created for analysis and visualization by assigning other colours or a colour gradient to classes. In addition classes are added or removed and class boundaries can be moved. If possible, the classes are represented by a histogram. Basic statistical analysis is also provided. The level of measurement or limited availability of the map data may restrain the functionality. For example, nominal data only supports colour assignment.

‘Comparison’. Individual map objects can be easily compared. A mouse-click on the map causes the value to be represented as a coloured bar (fig. 4). The bars are ‘sortable’ by name and value. The ten objects containing the largest or the smallest value can be represented as well. Again, the level of measurement of the map data may restrain the functionality. If the theme on the map, or the time span or period is changed the selected items are retained for further comparisons, if possible. The comparison tool also offers a navigation feature. A mouse-click on a bar temporarily highlights the map object and moves the object, if necessary, to the centre of the map.

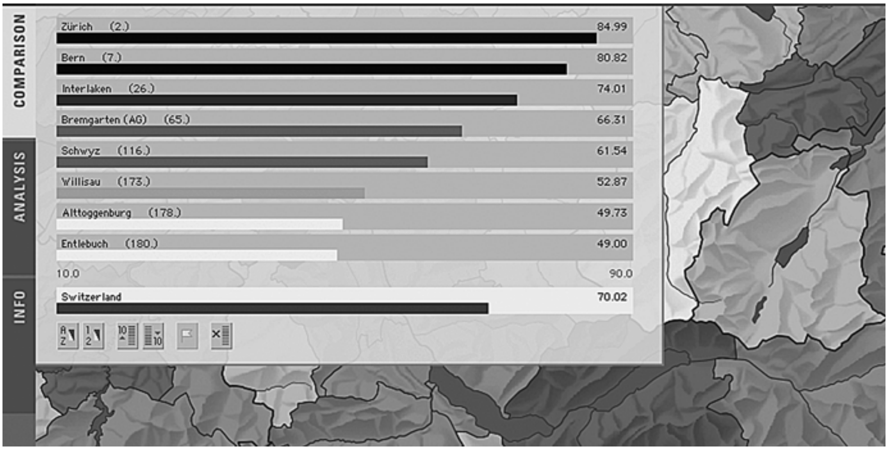

Fig. 4. Comparison tool as an example of 'Atlas of Switzerland 2' tool kit.

'Second map'. There are several ways to combine and compare two maps – 'side-by-side' display, 'alternating map' display, map overlay, etc. The *Atlas of Switzerland 2* offers map overlay whereby only one of the maps is active at any time. The transparency of the two maps can be individually adjusted in order to control the visual weight of each map.

12.5.3 Topics

The essence of a national atlas is the topics. As stated previously, the *Atlas of Switzerland 2* covers more than 1000 topics totalling more than 7000 maps. The largest domain is 'Nature and Environment' (over 650 topics) covering weather and climate, geology, soil, water, ice and snow, landscapes, flora, and fauna. Additionally, more than 350 statistical topics cover society, economy, state and politics. Several of these topics are also treated in a European context. The topics have been derived from dozens of sources.

Topics may provide several spatial resolutions (e.g., communes, districts, and cantons) and time spans or periods (e.g., monthly temperatures). Changes can be displayed in the form of an animation. Each map offers a few edited so-called second maps for combination. Second maps are thematically related and cartographically qualified – colour ranges and layer types (e.g., point symbol map onto choropleth map) differ. While statistical maps are virtually always point symbol maps or choropleth maps, more than half of the maps of the domain 'Nature and Environment' are raster maps.

Topics can be selected hierarchically (four levels) using thematically-arranged menu (*thematic navigation*). On each of the four levels, there are on average seven topics. As well as the topic selected, spatial resolutions and time periods can be changed on the theme panel. As a shortcut closely related topics can be selected on the theme panel without opening the menu. Once the topic has been changed, the *AoS*2 tries to find the best matching of spatial resolution and time period.

Some topics may not be intelligible to all, or the user simply may want to learn more about the topic background. If this is the case, additional information is most valuable. In this regard multimedia atlases are very flexible; they can provide different media. The *AoS*2 contains an information panel that is linked to the active thematic layer. It provides brief informational text about the topic depending on how the topic links to other multimedia elements. A total of over 600 pages of text, hundreds of photos, tables, sounds and videos will be offered.

12.6 Switzerland in 3D

As mentioned earlier, '3D Thinking' needs to be implemented to close the gap between 2D and 3D. The guidelines for the 3D section of the *Atlas of Switzerland 2* are that it must contain easy-to-use spatial navigation, have high rendering quality and use powerful visualization methods. Two types of perspective views are provided - block diagrams (figure 2) and panoramas.

12.6.1 Visualization and analysis

High rendering quality was achieved by high-resolution terrain and overlay data (up to 25 m) and powerful rendering methods. The *Atlas of Switzerland 2* rendering engine uses a ray-tracing method. Multi-resolution representation of terrain and overlay data accelerates the rendering process and improves the representation. As ray-tracing with high-resolution data is rather slow, a small preview image is integral part of the interface.

Thematically determined visualization methods are encapsulated into the product as visualization modules. The *AoS*2 contains a wide range of analytical, cartographic, and photorealistic visualization modules. Different modules can be combined. As the corrected weighted average of the colours of all activated visualization modules determines the final colour, the visual weight of each module can be specified. The majority of the modules offer additional settings and analysis tools. As regards to content, two groups of modules can be distinguished. These are analytical modules, exclusively based on the terrain model data itself (a few modules use additional parameters) and overlay modules that assign various 2D data onto the 3D map as textures.

Overlay of 2D data includes topographic data like lakes, forests, urban areas, and glaciers. Besides a satellite map module makes photorealistic 3D maps possible. A further forty topics qualified for 3D visualization from the subject areas atmosphere, lithosphere, hydrosphere and biosphere, and were implemented as 3D thematic cartography elements. In the 2D section individual cartographic representations can be created for analysis and visualization by assigning other colours or a colour gradient to classes. In addition classes can be added or removed and class boundaries can be moved.

Analytical modules with local spatial dependency are hypsography, slope, aspect, background (haze), fog and lighting. Visibility and lighting with cast shadows have global spatial dependencies that demand intricate calculations. The calculation bases are 2D coordinates for distance and background (haze), altitude for hypsography and fog, surface normal for slope and lighting, 2D surface normal for aspect and 3D coordinates for visibility. Lighting requires a light vector as an optional parameter. Distance and visibility need a point that can be selected on the 3D map. The colours of all analytical modules can be interactively altered, so five analytical modules offer the same features as the thematic overlays.

Among the further settings two are of special interest. Lighting offers a time and date selection tool to calculate the direction of the sun. A camera-related lighting method (keeping the angle between line of sight and light vector constant) for panoramic views generates artificial lighting.

Extracting vertical profile cross sections of the terrain is a well-known visualization method (fig. 5). The intersection points can be interactively selected and edited on the 3D map. The resulting intersection path is linked with a profile map that may contain not only the altitude but also thematic data. During queries the intersection path or the profile map, altitude, base map entries like mountains as well as thematic data are displayed on the profile map. The current position is marked on the 3D map.

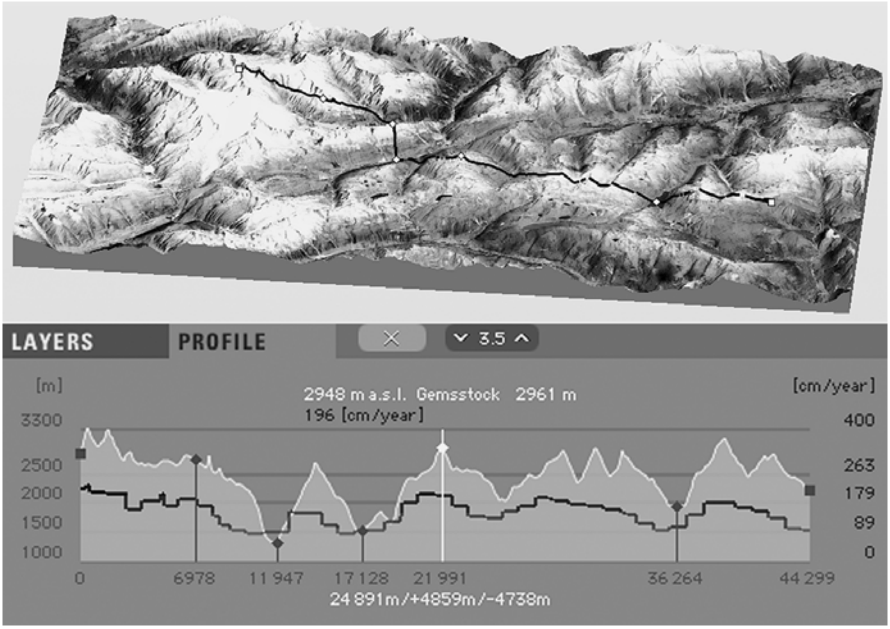

Fig. 5. Terrain profile from a panoramic view.

12.6.2 Navigation

Easy wayfinding demands constrained and intelligible navigation modes (e.g., stabilized horizon in panoramic views), The *Atlas of Switzerland 2* offers several discrete or continuous navigation modes in 2D or 3D space and huge lists of viewpoints. In 3D space a small preview image supports, amongst other things, interactive-continuous navigation. Related to navigation, two frames of references can be distinguished: exocentric (external view – appropriate for block diagrams), and egocentric (self-view – appropriate for panoramic views).

The preview image serves as a continuous navigation tool. The block diagrams can be rotated around two axes by mouse-drag. The rotation about the x-axis (in world coordinates) is constrained so that block diagrams will never be inverted. The selected area can be shifted using keys. Finally, a combination of mouse-drag and modifier key offers continuous zoom. The panoramic view can be horizontally rotated (yawing) and vertically shifted. Further degrees of freedom are handled either by mouse-drag combined with a modifier key, or by combinations of keys (vertical transformation of the camera (altitude), forward translation with a ground-level option - the camera follows the terrain, and zoom-in and zoom-out).

The 3D map itself serves as an accurate navigation tool. There are five modes: shift; zoom-in; zoom-out; position and line-of-sight; and ‘climber’. ‘Shift’ only provides for continuous movement (dragging) of the 2D image as long as the newly rendered image fits the moved image. For block diagrams only horizontal and vertical shifting is provided (2D map related). For panoramic views yawing (horizontal rotation, camera related) and vertical shifting accomplishes this criteria. The preview shows the resultant 3D view of the other navigation modes. Both block diagram and panoramic view support zooming. The rectangle selection tool is designed to select the 3D map area to accurately zoom-in. In panoramic view mode, a new observation *position* can be inserted directly into the terrain, while a suitable line-of-sight can be continuously selected with the arrow (fig. 6). The ‘climber’ (alpinist) mode accesses the mountain database. In panoramic view mode, the position can be placed on the top of a mountain. In the block diagram the selected mountain is centered. The position mode has its own climber variant, where a ‘modifier’ key moves the position to the top of the selected mountain.

A 2D map in two resolutions (2 km, maximum 500 m per pixel) serves as a navigation and orientation tool. It shows either the block diagram area, or the camera (position, line of sight, field of view) of the panoramic view. All parameters can be altered interactively.

In addition to the navigation modes in 2D and 3D space further navigation features are available. Whilst navigation in 2D or 3D space requires spatial sense, selecting predefined viewpoints from lists is a simple but limited way to navigate. The *AoS*2 offers several lists of viewpoints including mountains, passes, communes, etc., totalling nearly 7000 viewpoints. The resolution of the 2D reference maps is limited; with the large map has a maximum resolution of 500 m per pixel. Thus accurate values for all camera parameters can be put in text fields.

Extensive simultaneous queries facilitate navigation and orientation in 3D space. All objects of the hidden base map layers can be queried. Geographic regions, administrative entities (communes and cantons), urban areas, mountains, glaciers, passes and lakes are available. Terrain related queries include for each pixel on the surface altitude, national coordinates, aspect, slope, distance from the camera (panoramic view), and, if available, thematic information.

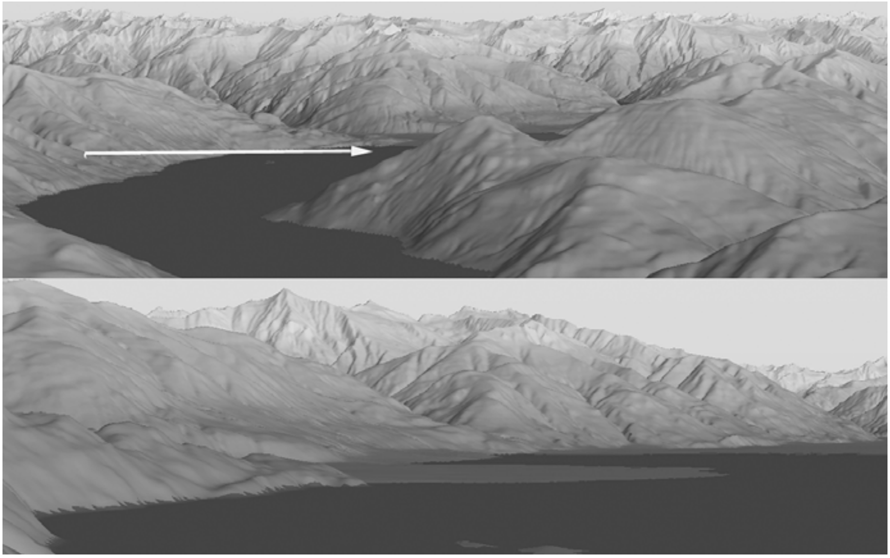

Fig. 6. ‘Navigation’ mode ‘position’ and ‘line-of-sight’.

12.7 Conclusions and outlook

The *Atlas of Switzerland 2* provides many requested features for interactive multimedia atlases in a now mature edition. The conceptual framework and modular design allow for sophisticated map authoring and future functionality extensions.

During its 10-year plan the *Atlas of Switzerland* will consecutively cover the main subject areas of interest. Each edition of the *Atlas of Switzerland* has a main theme for identification purposes. The *Atlas of Switzerland 2* provides maps from ‘Nature and Environment’. Edition 3 will treat ‘Traffic, Energy and Transportation’, and a further edition will focus on ‘Culture and History’.

Functionality development within the *Atlas of Switzerland 3* will include visualizations of multivariate point symbols and diagrams and network maps. Extended 3D visualization methods (sky, clouds, the moon and stars, waves and reflections) and 3D vector element handling and statistical 3D surfaces will also be part of the work. The atlas will offer new tools like user-defined labelling and advanced colour mixing, as well as the integration of external statistical data and GPS tracks. GIS techniques like selection and aggregation will be added. With a smart legend approach, the merging and augmenting of a legend and the provision of analysis tools (Sieber, Schmid and Wiesmann 2005).

Concerning future delivery platforms and product lines, interactive atlases will migrate to atlases on the Internet, to atlases for schools, or to extractions for regional atlases and tourist areas. Together with the *Atlas of Sweden* (Cramér and Arnberg 2005) the *Atlas of Canada* (Kremers 2005 and elsewhere in this book), the *Atlas of Germany* (Hanewinkel and Tzschaschel 2005) and many more, the *Atlas of Switzerland* has already established itself as a contemporary atlas product.

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