Panoramic Maps – Evaluating the Usability and Effectiveness

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ABSTRACT
This paper examines 3D mountain maps focusing on representations of skiing and hiking resorts. These kind of maps – also known as panoramic views or panoramic maps – offer a realistic look of the landscape. After clarifying important terms connected to the subject, the methodology of a self-administered survey is specified and the results are presented. The goal of the survey is to determine how panoramic maps are perceived and interpreted by various user groups, also in comparison with 2D topographic maps. Furthermore, questions about possible support given by techniques of digital panoramic map production were asked in the survey and are discussed in the paper. The results may help panorama artists to adapt or improve representations and production techniques of panoramic maps in the future. Besides the results strictly related with this study, ideas for increasing the attractiveness of panoramic maps by means of integration of new techniques (such as the linkage of panoramic maps with digital interaction forms) are discussed.

Keywords
panoramic map – red-green confusion – spatial perception – map reading – computer-generated 3D map – QR code

INTRODUCTION

Panoramas are mostly paintings with an artistic value. Compared to conventional 2D maps the realistic look of panoramic maps facilitates the understanding of the map by a majority of the users. Panoramic maps offer an overview of the shown region including areas of interest and tourist highlights, but the effects of occlusions and the missing accuracy represent a disadvantage. A panoramic map will never be a basis for planning an exact route. Hikers or active winter sports people are better able to identify their position on a 2D topographic map, as distances can be reliably derived only from this kind of maps.

In his study "Mountain Ski Maps of North America: A Preliminary Survey and Analysis of Style", the American cartographer Alex Tait (2008) describes the graphical styles of more than 400 ski resorts' trail maps in North America. He does not only mention the popular and most established panorama artists of North America James Niehues, Hal Shelton and Bill Brown, but also analyzes and categorizes the panoramic views in general. Following the study by Alex Tait (2008), the present survey deals with questions related to panoramic maps' usability and effectiveness adopting the example of a Swiss winter sport area.

In Switzerland, more than 200 ski areas are promoted with the help of panoramic views (Tourismus Schweiz, 2012). The majority of these illustrations are manually painted and is used as basis for cartographic features showing tourist facilities. This is also the case for the ski area map chosen for the survey. Most of the currently existing panoramic views were produced by Arne Rohweder and Winfried Kettler. Just a few other panoramic views were painted by other artists. One of them is Heinrich C. Berann (1915–1999), who was one of the pioneers in painting outstanding panoramic views worldwide.

There are many possibilities to obtain information about winter sports regions in the World Wide Web, but information about facilities and special offers are often nicely described, or beautifully illustrated by photographs. The importance of panoramic maps visually indicating the location of tourist highlights should therefore not be underestimated.

3D views in the World Wide Web are in most cases interactive. Users can navigate through the landscape, zoom and pan on the area of interest according to their needs. In painted panoramic maps the

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"interactivity" depends on the abilities of the panorama artist. Using perspective and distortion the panorama artists show important features and areas that would be hidden or less prominent otherwise. In this way the artist somehow "navigates" the user.

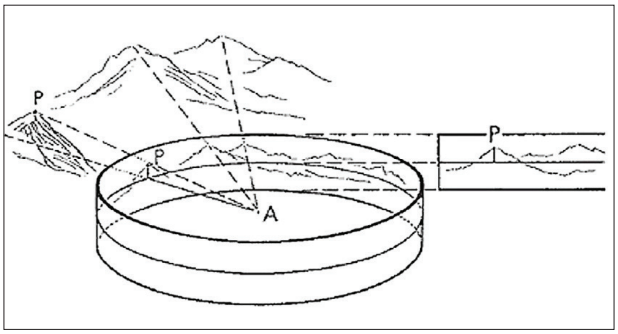

Figure 1. Principle of the construction of a panoramic view (Eduard Imhof, 1963).

TERMINOLOGY – PANORAMA, PANORAMIC VIEW, PANORAMIC MAP

The term "panorama" is derived from Greek (pan = all and horama = see). The meaning of this term has changed in the last 200 years. It is now commonly used to describe the sweeping view of a landscape surrounding an observer (Schumacher, 2012).

According to Imhof (1963), the term panorama describes a 360° view of the surrounding landscape from an elevated point. Projection rays are projected onto a 360° cylinder. No geometric construction constraints are specified (Figure 1). Strictly speaking we cannot, see a complete panorama in our field of vision by only moving the eyes without moving the head (Schumacher, 2012).

According to the authors' opinion, a painted or computer-generated panorama or panoramic view supplemented with cartographic content such as symbolization for tourist facilities can be described as a panoramic map. There are mainly two different styles of landscape representation in panoramas depending from the season: snow-covered landscapes represent winter; greenish-coloured landscapes represent summer time. Summer panoramas typically show a network of rambling trails, cable cars, chairlifts and other public transport systems. Additionally, winter panoramas contain ski lifts and ski slopes. Both types provide a general overview of the tourist area with its attractions. A panorama is not only used for spatial orientation, but it is also an indispensable advertising medium since it offers a more pictorial and descriptive view of the landscape compared to topographic maps (Figure 2).

METHODOLOGY OF THE SURVEY

The key objective of this survey is to investigate how panoramic maps are perceived and used by various user groups. The results may help panorama artists to adapt or improve representations and production techniques of panoramic maps in the future.

Totally 356 persons were directly asked by e-mail to take part to the self-administered survey. On the one hand, the study participants were recruited from the members of the International Cartographic Association's (ICA) Commission on Mountain Cartography, as well as from cartographers, geographers, surveyors, graphic designers and map enthusiasts from Germany and Switzerland. On the other hand, persons unrelated to maps were also recruited. An important number of non-experts were recruited in the wider social environment of the authors but they did not receive any additional support and have not been influenced completing the survey. The survey took place from April 14th to May 1st, 2012.

Figure 2. Panoramic view (left) and panoramic map (right): Aletschgebiet, Winfried Kettler.

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The survey's participant received by email the questionnaire form as PDF. Initially, some general questions were asked in order to query the user profile. Subsequently, six specific questions to the topic of this paper were asked. The study participants finally had the possibility to include comments about the possible optimization of the panorama's content and visualization. Answers and remarks were given through text boxes or by choosing the corresponding radio buttons or check boxes.

By chance, the number of duly completed questionnaires was exactly 100: 50 women and 50 men. The majority of the interviewed persons came from the German-speaking area (Germany, Austria, and Switzerland); the remaining participants (4%) came from Great Britain, New Zealand, Slovenia, and the United States. Based on the specified profession the participants have been divided in two groups: 38 interviewed persons were classified as experts, the other 62 were classified as non-experts. According to the user profiles, some further sub-groups were created for a more detailed evaluation of the survey as listed in Table 1.

The questionnaire presents figures of panoramic maps' snow-covered representations commonly used in winter ski areas. In order to better interpret the answers a specific user profile question was referring to the participants' practice of winter sports and to their use of panoramic maps.

The topic related questions, the results and the analysis of the survey have been divided into three thematic groups: visual and spatial perception, the use and understanding, as well as the production methods of panoramic maps.

	Participants (100)	Experts (38)		Non-Experts (62)	
Gender					
Male	50	31	82%	19	31%
Female	50	7	18%	43	69%
Handedness					
Right-handed	84	33	87%	51	82%
Left-handed	16	5	13%	11	18%
Age Group					
under 20	1	0	0%	1	1%
20-40	56	21	55%	35	57%
40-60	30	12	32%	18	29%
over 61	13	5	13%	8	13%
First Language					
German	96	34	89%	62	100%
English	3	3	8%	0	0%
Others	1	1	3%	0	0%
Winter Sports					
Practising	50	23	61%	27	44%

Table 1. User profiles of the participants.

RESULTS AND DISCUSSION

Perception

Colours play a crucial role in the perception of panoramic maps. In order to better assess their subsequent responses the participants were tested for possible red-green confusion, commonly called "red-green blindness". Generally this condition affects about 8% of all males. A reason for this restriction is a genetic defect on the X-chromosome. Since men have only one X-chromosome such a defect has an immediate impact. Women have two chromosomes X and can compensate eventual negative effects. Therefore only 0.4% of women worldwide are affected by red-green confusion (Jenny et al., 2007).

Red-green blindness was tested by asking participants to identify any difference in two equal panoramic maps where one of the two figures had been previ-

ously manipulated by the colour blindness simulator software ColorOracle (2012) (Figure 3). For uncertain reasons, the number of participants possibly affected by red-green confusion (participants not recognizing any difference between the two images) is unusually high. Totally 22% of the surveyed men and 6% of female respondents might be affected. Regarding the gender distribution, results from other studies could be approximately confirmed.

The use of colour is adopted by panorama artists in order to strengthen the spatial perception. Panoramic maps are therefore usually created in three parts: The

Due to this importance of the colour, the use of a grayscale image is expected to lead to a reduction of the spatial perception. In order to assess this assumption, a comparison between a poly- and monochrome panoramic map was included in the survey (Figure 5). The participants were asked: "Does the missing colour have any influence on your spatial perception?"

49 % of all participants felt impaired in their spatial perception when seeing the monochrome panoramic map. Only 37% of the experts felt irritated by the monochrome representation (Table 2).

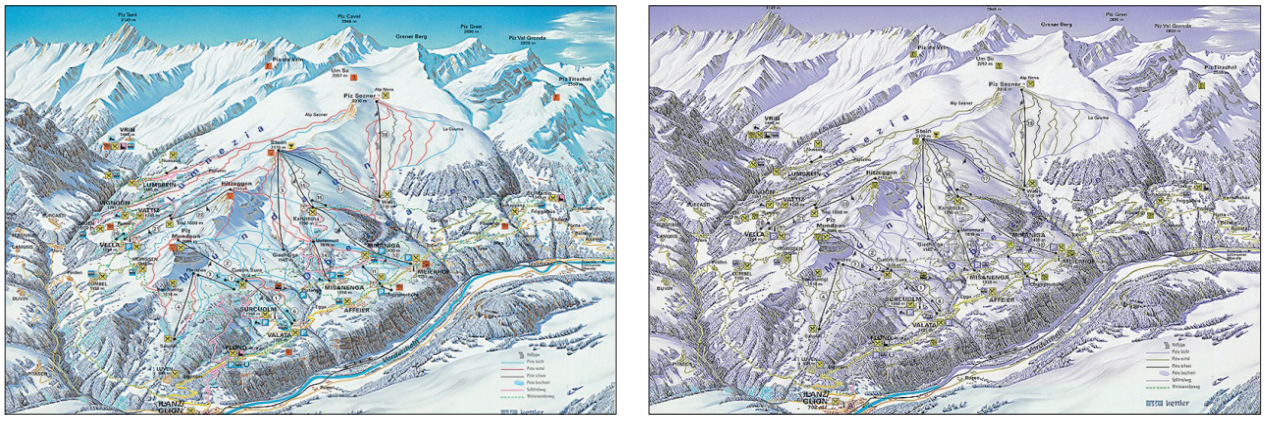
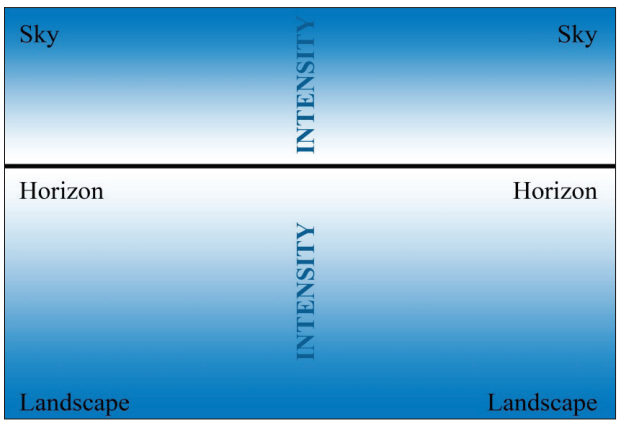


Figure 3. Normal vision (left) and red-green confusion (right): Panoramic maps of the winter sport area Obersaxen (Winfried Kettler). The figure on the right has been manipulated by the software ColorOracle.

foreground is observed from an elevated level towards the ground. The middle part of the panoramic map is seen from a relatively flat angle and includes all main (tourist) attractions and mountain scenery. The third section represents the horizon and the sky. Depending on the detail, a bigger or smaller section of the sky is represented (Jenny et al., 2010). Colour intensity of both the depicted landscape and the sky is reduced towards the horizon. This results in the so-called atmospheric perspective (Figure 4).



Fiure 4. Schematic representation of the atmospheric perspective.

This result may give new insights. The influence of colour (compared to grayscale) pertaining spatial perception in panoramic maps is lower than assumed. In the authors' opinion however, colours still act as an important information and orientation carrier. In polychrome illustrations it is easier to distinguish villages from vegetation cover and marked hiking trails and ski slopes can easier be differentiated. For instance, the degree of difficulty of the ski slopes can be visualized with colours. The use of colour helps the human eye focusing on the main content. For these reasons it is recommended to use colour in this kinds of panoramic maps.

Map Reading

This part of the survey investigates users map reading skills. The findings may lead to some conclusions about the usability and effectiveness of panoramic maps.

The first two questions were based on a comparison of a winter panoramic map of the alpine region Obersaxen made by Winfried Kettler with the corresponding section of a topographic map made by swisstopo. According to the initial questions for the user profile, 50% of

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	Experts (38)		Non-experts (62)		Total
Perception					
Normal vision	32	84%	54	87%	86%
Red-green confusion	6	16%	8	13%	14%
Influenced by Monochrome	14	37%	35	56%	49%
Not influenced	24	63%	27	44%	51%
Map Reading					
Piz Mundaun as higher	4	11%	17	27%	21%
Piz Sezner as higher (correct)	34	89%	45	73%	79%
Railway found in 3D	3	8%	11	18%	14%
Railway found in 2D	6	16%	32	52%	38%
R. found both in 3D and 2D (correct)	28	74%	12	19%	40%
Railway not found in any map	1	2%	7	11%	8%

Table 2. Summarized results, divided into experts and non-experts.

the survey participants practice a form of winter sport and are familiar with panoramic maps illustrated with snow-covered landscapes like the one showed in the questioning.

Firstly, the survey participant was asked to decide, which mountain (either Piz Mundaun or Piz Sezner) is situated higher than a predetermined and indicated reference point (Figure 6). In the second question the users had to identify on which of the two maps a railway is shown.

non-experts detected only the railway located in the North of the topographic map (Table 2). An important aspect for the assessment of these two questions is the variation of the direction of view. Conventional topographic maps are mostly oriented to the North as the one pictured in Figure 6 on the right. In contrast, panoramic maps are usually oriented according to the objects planned to be at the center and to the tourist highlights. In Figure 6 on the left, Winfried Kettler displays the region Obersaxen with a direction of view

Figure 5. Polychrome panoramic map (left) and monochrome panoramic map (right): Obersaxen, Winfried Kettler.

Overall, 79% could correctly identify Piz Sezner as the higher mountain compared to the predetermined reference point on the panoramic map. 89% of the experts correctly identified Piz Sezner as the higher peak while 74% of them correctly identified the railway in both maps. 72% of the non-experts were able to detect Piz Sezner as higher, but only 19% of them could detect the railway in both figures. 52% of the roughly from North to South. Probably, non-experts did not look for the railway line in the foreground of the panoramic map expecting the railway to be in the valley facing away from the user. This misinterpretation might be caused by the North to South orientation of the panoramic map, which is contrary to common 2D maps.

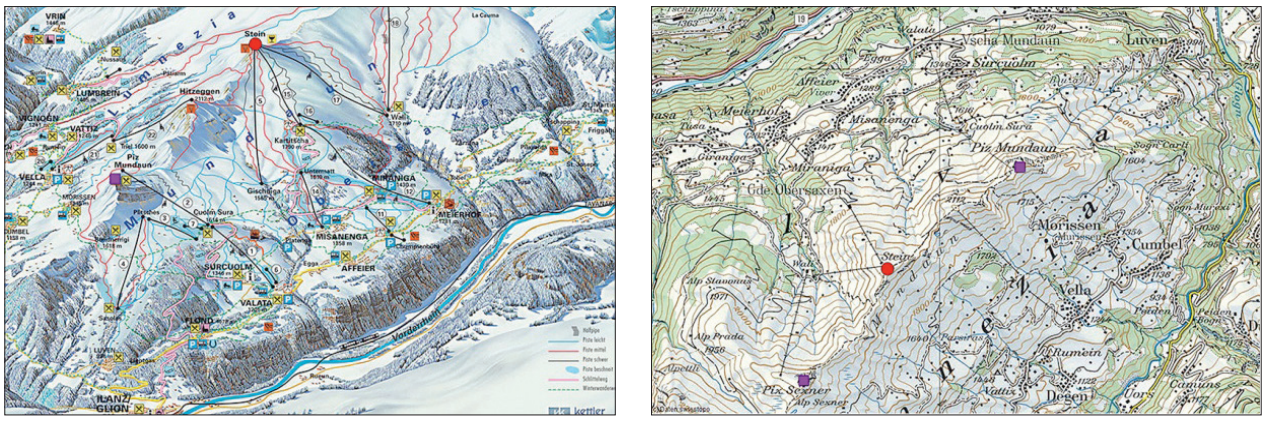

Figure 6. Panoramic map (left): Obersaxen, Winfried Kettler; Topographic map (right): map.geo.admin.ch, Obersaxen (accessed May 9, 2012)

When asked about the preference between the panoramic or the topographic map, 82% of the left-handed participants choose the panoramic map while only 67% of the right-handed people prefer the panoramic map. In the authors' view this result may confirm the alleged higher creativity of left-handed people, but this thesis has been discussed in the world of science controversially.

Computer-Generated Panoramic Maps

Another focus of this survey is represented by the present and future technical possibilities for the production of panoramic maps. In a first question the participants were asked if they judge the replacement of traditional handmade panoramas by computer rendering methods as being possible in the near future. In a second question the user were asked to list known software products and/or web applications for the production of panoramas.

Nowadays, different technical instruments for producing panoramic maps are available (e.g. tablet and the Photoshop airbrush tool, digital elevation models (DEMs), software programs) and a variety of software for creating panoramic maps exists. Digital products can be divided into two main groups. On the one side, the group of programs allowing the representation of panoramic maps from different perspectives, viewing directions and with different enhancements. On the other side, software for the production of 3D cartography and panoramic maps, applying bending to DEM (Table 3).

The question concerning the future replacement of traditional handmade panoramas by computer-generated panoramas presents following results: 47% of the expert survey participants believe that software generated panoramic maps will be predominant in the near future. Among the non-experts, 63% share this opinion. Experts may be more aware of the difficulties related with a purely computer-based generated process.

In the answers to the second question about known software products only 17% know Google Earth. A possible interpretation of this result is the non-straightforward association of this software with panoramic maps. Experts also mentioned programs for generating panoramic maps such as Bryce, Terrain Bender and Terragen (Table 3).

Remarks of the Participants

Few participants, primarily non-experts, complain about the effects of occlusion and the missing accuracy of panoramic maps. However, these effects are difficult to avoid on panoramic maps. A scale cannot be determined for a panoramic map, as every part of the representation has its own scale depending on global and local distortions and due to central perspective.

Furthermore, a small number of survey participants criticize the low resolution of the provided images. However, several factors support the authors' choice of the relatively low resolution. On the one hand information boards in the winter sports areas are mainly observed from larger distance and users generally spend only a small time looking at those boards (Schobesberger et al., 2007). On the other hand especially people practicing winter sports are affected by equipment such as helmets or ski goggles that restrict the field of view.

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	Experts (38)		Non-Experts (62)		Total	
Future						
Computer-generated	18	47%	39	63%	57%	
Traditional handmade	20	53%	23	37%	43%	
Program						**Type**
Knows some software	19	50%	13	21%	32%	
Doesn't know any software	19	50%	49	79%	68%	
Google Earth	10	26%	7	11%	17%	show
Atlas of Switzerland	5	13%	3	5%	8%	show
Terrain Bender	7	18%	0	0	7%	generate
Bryce	4	11%	0	0	4%	generate
Terragen	4	11%	0	0	4%	generate

Table 3. Summarized results pertaining present and future technical possibilities for the production of panoramic maps. The last five rows show the top five programs for the representation or generation of panoramic maps.

CONCLUSION

In the authors' view, the results of the preliminary and self-administered survey are not very surprisingly and support former theses and statements about this subject. It is worth mentioning that not all the results are convincing due to the little number of participants for some particular users sub-groups.

Nevertheless, some findings may help panorama artists in the optimization of future work projects. Some results seem to indicate possible existing issues related with the orientation of the panoramas – finding the right cardinal direction. The direction of view is important for understanding panoramic maps, but variations in the viewing direction are difficult to avoid. The inclusion of a compass rose could nevertheless be a useful addition to future panoramic maps for providing a rough orientation. A previous analysis of Swiss panoramic maps showed that just a few panoramic maps include this kind of information (Spengler, 2012).

Nowadays, graphic software, DEMs, and 3D visualization programs such as Google Earth or the Atlas of Switzerland can be helpful for creating panoramic maps. Interviews with the very few Swiss panorama painters confirm this thesis. Just a few years ago the collection of the necessary data and information about a region represented a demanding part of the panoramic view's generation process. The artists used aerial pictures, photographs, sketches and other illustrations from the area of interest. Nowadays this work is facilitated by the existing software and available information. Currently, modern digital resources are used by panorama painters as a support for creating panoramic maps. In the future however, the use of completely computer-generated panoramic maps will rapidly increase as the programs are becoming more and more widespread. In the authors' view, despite the increasing importance of photorealistic panoramas generated automatically from aerial photographs, the artistic style of painted panoramic maps will not disappear completely.

Beside the above mentioned suggestions for the improvement of the panoramic maps' production process, a further option for increasing their commercial, but not cartographic attractiveness could be the inclusion of digital interaction forms. Modern pattern recognition software, which is for instance implemented in smartphones, offers new perspectives for map use (Dickmann et. al, 2012). Panoramic maps are often presented on large-format information panels usually placed outside on attractive locations close to tourist facilities. Frequently, information panels with the size of several square meters are used. Such dimensions are perfectly suitable for QR codes (quick response codes) as additional information carriers. The target audience is the constantly rising numbers of smartphone holders who have the option to scan such QR codes to receive quickly and without any typing websites, phone numbers, addresses, vCards, access data for WLAN or geo-data. Traditional panoramic maps could be easily enriched by QR codes used for digital information transfer and therefore promote this form of visualization as a tourist information carrier.

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