Multimedia integration of cartographic source materials for researching and presenting phenomena from economic history

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Abstract: The article presents a framework for integrating historical sources with elements of the geographical space recorded in unique cartographic materials. The aim of the project was to elaborate a method of integrating spatial data sources that would facilitate studying and presenting the phenomena of economic history. The proposed methodology for multimedia integration of old materials made it possible to demonstrate the successive stages of the transformation which was characteristic of the 19th-century space. The point of reference for this process of integrating information was topographic maps from the first half of the 19th century, while the research area comprised the castle complex in Kórnik together with the small town – the pre-industrial landscape in Wielkopolska (Greater Poland).

On the basis of map and plan transformation, graphic processing of the scans of old drawings, texture mapping of the facades of historic buildings, and a 360° panorama, the source material collected was integrated. The final product was a few-minute-long video, composed of nine sequences. It captures the changing form of the castle building together with its facades, the castle park, and its further topographic and urban surroundings, since the beginning of the 19th century till the present day.

For a topographic map sheet dating back to the first half of the 19th century, in which the hachuring method had been used to present land relief, a terrain model was generated. The transition from parallel to bird's-eye-view perspective served to demonstrate the distinctive character of the pre-industrial landscape.

Keywords: old maps, economic history, multimedia integration, multi-perspective visualisation

1. Introduction

The following study resulted from adopting an interdisciplinary approach to research on the changing space management in the 19th-century Central Europe. This interdisciplinarity is a product of combining a historical approach with a geographical one in order to study past reality recorded in unique cartographic sources. The central objective of the framework presented was to merge the information from historical sources with the elements of geographical space recorded in old cartographic materials. The aim of the project was to elaborate a method for using cartographic sources as well as adapting and integrating other sources of spatial information for the purpose of researching and presenting phenomena from economic history. The period analysed was the 19th century, due to the transformations taking place at that time. As of the 40s and 50s of the 19th century, Wielkopolska started witnessing great changes connected with the development of economy, industry, and urbanisation. In order to distinguish this stage of transformation from the earlier one, the first half of the 19th century is called the pre-industrial period.

The value of the adopted research approach lies in the fact that it draws from the diverse character of the above-mentioned disciplines, their varying tools and resources, theoretical foundations, and research methods. The elaborated method involves the integration of topographic and economic elements present on maps and in other source materials. Actions performed on the gathered materials led to creating a multimedia visualisation.

The integration of old maps with other spatial data sources was presented using the example of an area representative of the pre-industrial Wielkopolska region – namely, the Kórnik Castle and the small town linked to it historically and architecturally. The choice of the research area was a resultant of several premises. The most important factor was the abundance of research material. Thanks to the great importance of the castle and its prominent successive owners, numerous documents and various materials connected with the castle's functioning were produced throughout the years. They either describe the space, or, at least, refer to it. The castle is a residence typical of the Wielkopolska region, one of the few undestroyed ones, and the only one to have retained its unchanged form since the 19th century. In the topographical sense, the castle with its surroundings constituted the dominant feature of the analysed area. What also contributed to choosing this particular area was the fact that today, the castle houses a museum and a library of the Polish Academy of Sciences. The rich history of this place has been recorded in many documents, plans, and other materials, which are kept in the library collection.

2. Methodology

2.1. Criteria for ordering the source material

The diverse source material collected called for some form of ordering. It was necessary to establish the criteria for classifying and combining the varying source materials. The material obtained during the queries was classified according to three criteria: chronology, scale, and type of perspective. Chronology-wise, the oldest of the graphic materials used dated back to the 20s of the 19th century. This group included, among others, a so-called *Urmesstischblatt map*, recording the pre-industrial state of the area. Materials from this period were the basis for showing changes to the castle and its surroundings that had taken place in the 19th century. The later materials, chronologically speaking, referred to the castle's reconstruction begun in 1842 (Kąsinowska, 1988). The last group comprised the materials showing the analysed area after the said reconstruction, in the second half of the 19th century.

Classification of source materials by scale made it possible to organise the information according to the level of detail. The basic level was the one of topographic sources, which in the case of the collected maps meant the scale 1:25,000. On the basis of those materials, it was possible to interpret the spatial changes in castle surroundings, e.g. the network of main roads, watercourses, ways of using the land, building development in the town and on the castle grounds. Materials at this level of detail were also used as the source of information about land relief (Graf, 2014).

The next scale bracket was made up of data at a cadastral level. These included plans of the castle and its surroundings. Their level of detail made it possible to notice changes in the arrangement and division of space, the layout of paths and alleys, and the location of bridges and footbridges, which also constituted elements of the garden. Materials in this scale bracket were also a valuable source of information about the castle – the changing form of the building itself, as well as the resultant changes in the network of paths and roads. The greatest level of detail was present in blueprints of the castle, views of its facades, vertical and horizontal projections, and cross sections. Those documents provided information about what the castle used to look like and about the plans for its reconstruction.

The third criterion for the classification of source materials was the type of perspective used to present the information collected. In the proposed data integration process, three kinds of perspective were used to present the third dimension. In the case of a topographical map, the usual choice is the parallel perspective. By definition, a map has no perspective, since it is constructed in such a way that the reader is located exactly above its every element. It is assumed, however, that landforms are presented on a map in the parallel perspective (Robinson et al., 1988).

The castle models superimposed on the plans were presented in the video using the bird's-eye-view perspective. It is in line with the natural human perception of reality (*Lexikon*, 2001). Projection is made onto an oblique surface with a perpendicular viewing axis. The type or perspective applied made it possible to generate video sequences presenting three-dimensional models of the 19th-century castle, against the background of the old plans. In this way, a simulation was made of how the area in question evolved throughout the 19th century. The simulation was filmed from a "bird's eye view". The same perspective was used to present the *Urmesstischblatt* map, integrated with a three-dimensional terrain model. This made it possible to visualise the hypsometric diversity of 1830 recorded on the plane of the map.

Yet another type of perspective was used while filming a panorama of the castle's surroundings. The panorama, like the bird's-eye-view perspective, is a subtype of the central perspective. In this case, however, the projection is made onto a vertical surface (Hake and Grünreich, 2002).

2.2. Research materials

Every map presents information about the spatial aspect of the environment and defines this information within a period of time sufficient for significant changes of the landscape. The 40s of the 19th century in Wielkopolska mark the beginning of the industrial revolution, a result of the industrialisation trend from the West (Lorek, 2011). The Prussian *Urmesstischblatt* topographic map from 1830 presents a fragment of the Central Europe of the pre-industrial period (Klemp, 2000; Lorek, 2009). It constitutes the only consistent cartographic source providing information about the state of the natural environment in the region. The map sheets on a scale of 1:25,000 were made since the first half of the 19th century (Schroeder-Hohenwarth, 1958). The *Urmesstischblätter* maps, made only in the form of manuscripts, have survived till today in the cartographic collection of the Berlin State Library (Engelmann, 1968). It was one of those maps that constituted the main source material in the information integration process described.

Apart from *Urmesstischblätter*, other graphic sources were also used in the research. The collected materials might be broken down into the following types (Figure 1):

- Blueprints of castle facades, as well as horizontal and vertical projections dating back to the 20s of the 19th century. In 1826, the Kórnik castle became the property of Tytus Działyński. As the new owner, he had plans to arrange a reconstruction of the castle in the first half of the 19th century. Various blueprints of the castle elaborated for this purpose have been preserved. They present facades, projections (vertical and horizontal) of particular storeys, and cross sections. The researcher has used the drawings of the castle facades dating back to the castle surveying inventory performed by Abicht in the years 1826-27. It is thanks to them that we know what the

castle looked like since the 18th century till its reconstruction in the mid-19th century. Moreover, the study drew on one of the reconstruction blueprints from 1828, by Karl Friedrich Schinkel.

- Plans of the castle and its surroundings, presenting the spatial distribution of particular buildings and the detailed layout of the garden with the neighbouring farm facilities, such as a distillery, a brewery, a granary, and a smithy. The plans record the appearance of the complex before and after the 19th-century reconstruction and numerous details regarding the shape of the castle buildings and their surroundings. In the process of source material integration, two plans were used. The first one was the 1827 plan by Ziehlke, which presented the castle and the garden in the form that they had acquired as early as the 18th century. The post-reconstruction version was updated and redrawn by Biederman in his 1862 work. Both plans were made on a scale of approximately 1:1250.

- The *Messtischblatt* map presents the state of the area in the second half of the 19th century (Krauss, 1969). It constitutes very good comparative material for studies making use of the *Urmesstischblatt* map, and for two reasons: the map is made on the same scale and maintains the same division into sheets; besides, it presents the area's state resulting from changes associated with the industrial revolution and the economic transformation. What is more, the *Messtischblatt* map, despite its equal scale, is of greater geometric precision, because it was made by way of the improved, secondary triangulation, and printed using the technique of lithography (Lindner, 2003).

Fig. 1. The integration of old maps with other spatial data sources

A separate category of source materials was the descriptive information. Information provided in those materials described the reality presented on maps, plans, and graphics. A variety of source materials was ascribed to the geographical space in question. This enabled the compilation of the collected source materials and the creation of a new approach to presenting phenomena from the economic history.

2.3. Stages of data integration

On the basis of the presented materials, a method was proposed for integrating a wide variety of sources in a multimedia form. According to Medyńska-Gulij (2015), a comprehensive approach to geographical space, which entails using various modes and perspectives of cartographic presentation, can be attained by creating a video with cartographic visualisations. Smooth combination of several cartographic visualisations makes it possible to foreground certain historical and geographical phenomena or particular features of them. As far as the way of perceiving the phenomena is concerned, a vital role is played by the historical perspective, as well as the geographical one (the latter being associated with the scale of presentation). Key significance is also attached to the changing means of graphical expression used in topographic maps, site plans, and other plans, and to the graphical style of castle facade designs (Medyńska-Gulij, 2013).

On the basis of the transformations of maps and plans, graphic processing of old drawings, texture mapping of the facades of historic buildings, and a 360° panorama, the source material collected was integrated, resulting in a several-minute-long video. It captures the changing form of the castle building together with its facades, the castle park, and its further topographic and urban surroundings, since the beginning of the 19th century till the present day (Figure 2).

The video consists of the following nine sequences:
1. a manuscript section of the *Urmesstischblatt* map (pre-industrial state, 1830);
2. the *Urmesstischblatt* sheet integrated with a 3D model of land relief;
3. the 1827 plan by Ziehlke;
4. a 3D model of the 18th-century castle, created on the basis of the measurements made by Abicht in 1826-27, superimposed onto the plan from 1827;
5. the 1862 plan by Biederman;
6. a 3D model of the castle presenting Schinkel's reconstruction blueprint from 1828, superimposed onto the plan from 1862;
7. a 3D model of the castle after its reconstruction in the mid-19th century (the state preserved till today), superimposed onto the 1862 plan;
8. a *Messtischblatt* sheet (the state of the area during the period of economic development, 1880);
9. a contemporary panorama of the surroundings, taken from the castle tower (2015).

The video begins with a topographical image, presenting the view of an *Urmesstischblatt* sheet from the linear perspective. In order to demonstrate the distinctive character of the terrain, a digital terrain model was generated for the area presented in the *Urmesstischblatt* sheet used. In this map, the terrain was presented using the hachuring method, which is unreadable in the case of considerable height differences. Numerous short hachures may cause difficulties in presenting landforms. For this reason, an additional source of information about the terrain was used – namely, a *Messtischblatt* sheet, where the terrain was presented using the isoline method. As a result of integrating the above materials, the flat image of a two-dimensional space recorded in the *Urmesstischblätter* was upgraded to a three-dimensional view and shown in the video from a bird's-eye-view perspective. Thanks to that, the viewer can spot real changes in the terrain displayed against the 19th-century base. The method has proven very effective, and the effects are most noticeable in the case of watercourses or water reservoirs, owing to big denivelations of the terrain. The above actions were carried out using the ArcGiS software.

In a later part of the film, there is a smooth transition and the view is zoomed in to present the castle and its surroundings as it was in 1827 (a cadastral view). In the following sequences, the 3D castle models were fitted into their outlines presented on two plans. Three castle models were created: one showing the castle's condition in the 18th century, one representing a blueprint of the castle's reconstruction, and one demonstrating its state after the said reconstruction. The models created constituted the most precise (after its topographical and cadastre counterparts) take on the past reality. The information needed to elaborate the models was drawn from the preserved blueprints and drawings of the castle's projections from particular periods, as well as their descriptions and other source materials. In the video, the 3D model created for the blueprint by Schinkel was fitted into the 1862 plan. This resulted from the compatibility of both those sources with the castle's owner's construction brief. A distinctive feature was the location of the main entrance to the residence on the other side of the building.

The last model presents the castle's state after its reconstruction completed in the second half of the 19th century. Its final shape was largely based on the blueprint by Schinkel; however, a number of changes had been introduced. Onto the above model a texture was superimposed, created on the basis of photographs taken in the autumn of 2015. Due to the difficulties in photographing some of the castle walls (moat, lack of entry, trees obscuring the walls), it was necessary to make some adjustments of the photos obtained, using a graphics editor (Photoshop). All photographs were adjusted to the right proportions with the aid of graphic tools. The castle models were created in the SketchUp software, on the basis of the real size of the building's footprint. In most cases, equal shapes and proportions were retained. Also in this part of the video, bird's-eye-view perspective was used, making it possible to present the reconstructed castle and its surroundings from various directions. Three-dimensional castle models superimposed onto the appropriate plans penetrated each other in a chronological order. Thanks to the fact that the models were fitted into the old plans in a precise

manner, the viewer had a chance to see what the castle and its surroundings used to look like in the particular periods of the 19th century.
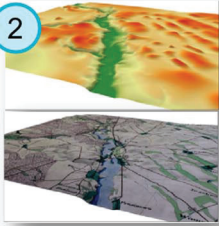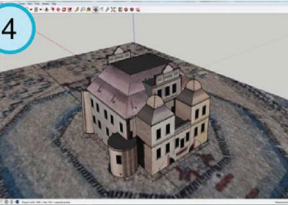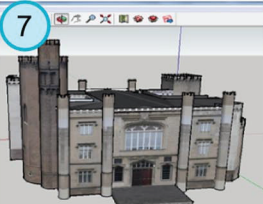
①	Manuscript section of the Urmesstischblatt map (pre-industrial state, 1830)	②	The Urmesstischblatt sheet integrated with a 3D model of land relief
③	The 1827 plan by Ziehlke	④	3D model of the castle, created on the basis of the measurements made by Abicht in 1826-27
⑤	The 1862 plan by Biederman	⑥	3D model of the castle presenting Schinkel's reconstruction blueprint from 1828
⑦	3D model of the castle after its reconstruction in the mid-19th century	⑧	Messtischblatt sheet (the state of the area during the period of economic development, 1880)
⑨	Contemporary panorama of the surroundings, taken from the castle tower (2015)		

Fig. 2. Sequences of the film

Maintaining the chronological order, a *Messtischblatt* sheet was then displayed in the same perspective. The sheet presented the castle's state in the period of great changes associated with economic growth. On the map, new buildings had appeared, the shape of some towns had changed, and so had the layout and number of roads. A valuable addition to the information collected was the view from the castle, from where the local landscape had been filmed. In a sunny weather, a 360˚ panorama was shot from the top of the highest castle tower. Combining this information with the generated three-dimensional model of the 1830 space enables a comparison of terrain presentation methods on 19th-century maps. Besides, it foregrounds the changes having taken place in the castle's immediate surroundings.

An important tool in the process of directing the video was the possibility of presenting the images from varying perspectives. This enabled a visualisation of the new views of the space studied, and a presentation of the relationships which would not have been apparent from a single-source analysis (Medyńska-Gulij et al., 2015). The multimedia used were additionally supplemented by music, which correlated with the successive sequences and transitions within the video. The nocturne by Fryderyk Chopin made the presentation more expressive, especially because pieces composed by this very artist were frequently listened to in the castle's halls in the 19th century.

3. Conclusion

The proposed video, with its particular order of sequences, may be considered a distinctive geocomposition, showing changes happening in geographical space, associated, broadly, with economic development. In terms of topography, there were noticeable changes in building development; brickyards were opened, towns expanded, the layout and density of the road network changed. There were also transformations and regulations of the watercourses and water reservoirs. An important phenomenon was the gradual appearance of railways, which largely influenced the distribution of newly erected residential and industrial buildings (Lorek, 2009). The above changes are very well visible in the two 19th-century topographic maps mentioned above. The *Urmesstischblatt* map recorded the pre-industrial state, whereas the second source already contained some features characteristic of the next period in economic history.

The multimedia integration proposed also made it possible to track changes in the various cultural elements noticeable in the historic castle and park complex with farm buildings. The preserved planning, architectural, and graphic sources regarding the castle in the 19th century enabled the reconstruction of its previous state and the most important changes to the building and its surroundings. Most importantly, the 18th-century appearance of the castle, as well as the partly realised blueprint from 1828, and the present state of the castle, were all reconstructed in a three-dimensional form. The video sequences demonstrate dramatic differences in the architecture of

the reconstructed building and its chosen blueprints. An important change had also been made to the castle's entrance. Formerly, it used to be located at the same side as the garden, whereas after the reconstruction it was relocated to the other (northern) side. Apart from the documents representing the facades and projections of the building, plans from the period also contain some details associated with the castle's reconstruction. Beside the evident detailed changes in the building's footprint, the new entrance has also been marked. One can also see the changes in the arrangement of the garden and its immediate surroundings, e.g. a new road along the lake, joining the farm buildings to the castle and the town, and a French-style garden transformed into a park.

The multimedia integration also enabled a three-dimensional presentation of hypsometric diversity recorded in the 1830 map and its juxtaposition with the map from the end of the 19th century as well as the contemporary panorama. On this basis, one may track the changes in land relief and land use. The contemporary panorama is confined in the north and in the east by a high stand of trees. In the west, however, there is a distinctive, unchanged shape of the lake, while north of the castle one may see the widely expanded Kórnik (in comparison to the 19th century).

The presented method of a specific presentation of a "slice" of geographical space gives rise to new methods of using multiple sources. Thanks to the use of various perspectives, smooth transitions, and the mutual penetration of images, the proposed method enables the reconstruction of the past layouts and spatial structures. On the basis of the integrated source material it is possible to generate images of past reality according to a new approach and from varying perspectives. Multi-perspective perception might facilitate the perception of the form and size of the buildings in question, but it may also be used to demonstrate the stages of historical and urban changes. Besides, the presented way of visualising the geographical space enables an integration of multiple sources which are seemingly incomparable for a researcher or an observer. The method described may enrich the perception of both public users and professionals, such as historians, librarians, archivists, or geographers.

Acknowledgments

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