# 22 Cartography and the use of animation

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## 22.1 Introduction - Why cartographic animation?

Visualization of spatial data is inextricably linked to maps. Maps are the ultimate tools to give insight in spatial relations and patterns. Maps are the result of the cartographic visualization process. This process is considered to be the translation or conversion of spatial data from a database into maps and map-like products such as those linked to multimedia, virtual reality or animation. During the visualization process, cartographic methods and techniques are applied.

However, as soon as the amount of spatial data to be displayed becomes huge a creative approach is needed in design to keep the map readable. This is especially true when the map must to express spatial processes. Most GIS users study processes and require means to visualize these for a better understanding or presentation. If limited to single maps, overly complex maps can result. Alternative solutions are to split the processes in smaller events and show these events as individual maps. These map series, however, are difficult to deal with, especially if presented individually on-screen. An interactive dynamic display is one solution to the complex requirements of the cartographic display.

An expressive form of dynamic visualization in the context of the spatial data handling process is cartographic animation, which indeed allows for the representation of very complex processes. Additionally, they can have a great impact on the viewer. They can deal with tangible data, such as terrain surfaces or urban environments, as well as with abstract or conceptual data, such as data on climate or population density. Animations not only tell a story or explain a process, they also have the capability to reveal patterns, relationships or show trends which would not be clear if one would look at the individual maps only.

The demand for animation arises largely from the need to deal with real world processes as a whole or simulations of those processes, rather than single time-slices. Static paper maps are limited in their capacity to visualize models of for instance planning operations. However, the on-screen map does offer opportunities to work with moving and blinking symbols and design options as transparency, and as such is very suitable for animations. Animations representing geospatial data can depict change in space (position), in place (attribute), or in time. Cartographers have been tempted by animation for many years, even before the demand from fellow geoscientists. During the sixties the non-digital cartoon approach was followed (Thrower, 1961) During the eighties technological developments gave a second impulse to cartographic animation (Moellering, 1980)while a third move on animations is currently ongoing as a result of a new form of distribution created by the World Wide Web.

Animations are a challenge to cartographers. They are about change. Peterson said: "what happens between each frame is more important then what exists on each frame". Since cartographers have mainly developed tools and rules for the design of static maps, this statement should be a cause for concern. We now have to answer question such as: How can we deal with this new phenomenon? Is it possible to provide the producers and users of cartographic animations with a set tools and rules to create and use animations? Currently a great deal of research is associated with animation in cartography, and issues related to representation, user tasks and the nature of the data to represent are subject of discussion. Current research tries to answer questionrelated to these issues (Blok, 2005; Fabrikant and Goldsberry, 2005; Harrower, 2003; Midtbø and Boro, 2005; Morrison and Tversky, 2001).

## 22.2 Spatial data and the type animations

For many, a cartographic animation is the depiction of change over time. The division in temporal and non-temporal animations is often taken for granted. The temporal animation is used to display time in a temporal sequence. The non-temporal animation is used to explain spatial relations by presenting individual map images in a sequence that is not related to time. This last category can be sub-dived into animations that represent a successive build-up and those that offer a changing representation of a phenomenon. It is the relation between spatial data's components and display time (the moment a viewer sees the animation), which distinguishes the three categories from each other (Kraak and Klomp, 1995)– see figure 1. It is thought that interaction and cartographic animation are coupled under every circumstance if one intents to use them efficiently.

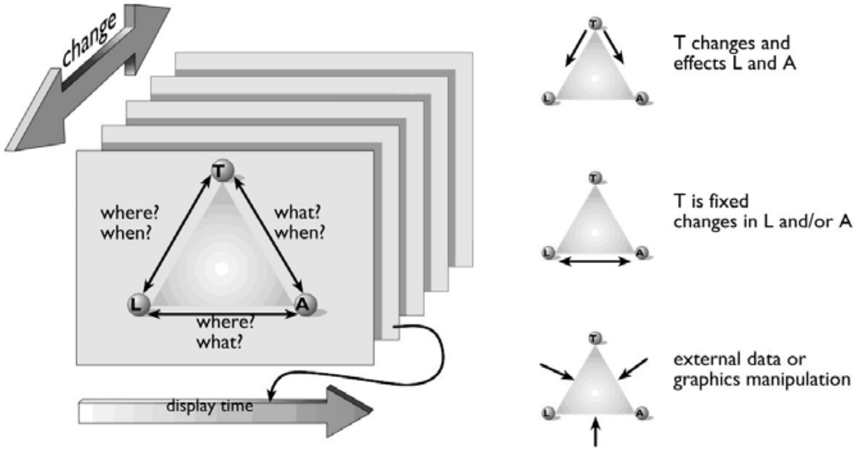


**Fig. 1**. Animation are about change, change in spatial data's components location, attribute and time. The nature of the change in the components can be used to classify the animations. The upper left diagram shows the type of changes that defines a temporal animation. The middle left diagram shows the nature of change that represents animation with a successive build-up. The lower left diagram shows that animation of changing representations is influenced by external changes.

## Animation and time series

These animations show change of spatial pattern patterns in (world) time. Since time is plotted against display time a transition between individual frames implies change in the data's locational and/or attribute component. Time units can be seconds, weeks, or years. Temporal animation can also deal with time aggregates, for instance, the display weekly cycles. A weather broadcast provides samples of both: Animation with the moving clouds or changing temperatures. Other examples of these animations are those of the Dutch coastline from Roman times until today or a country's boundary changes during the last three centuries

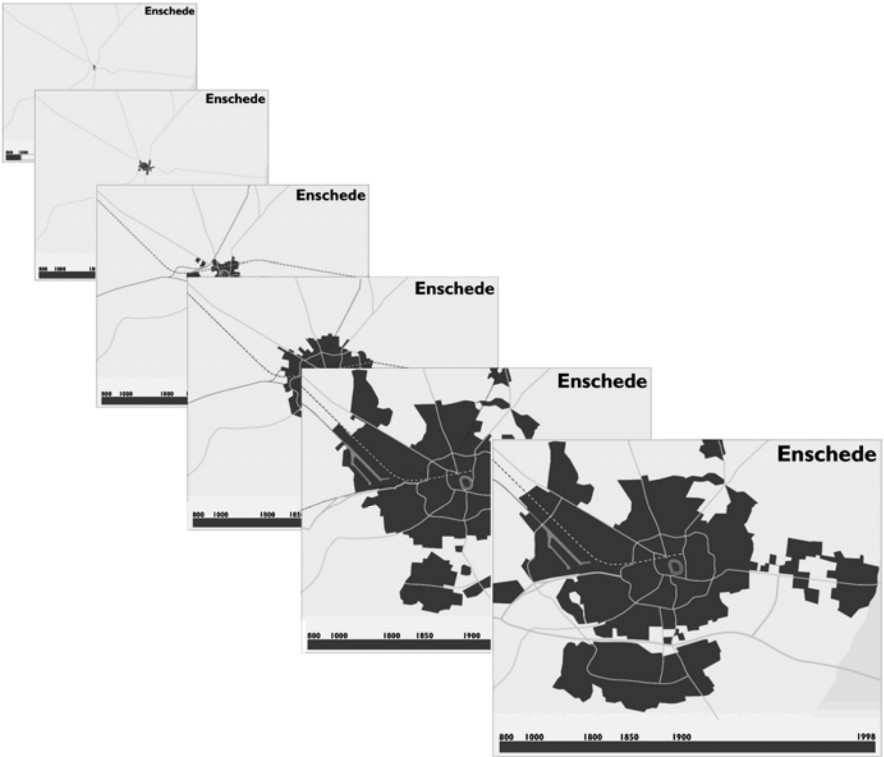


**Fig. 2.** Animation and time. The example shows frames from a sequence representing the urban growth of the city of Enschede in the Netherlands. Each frame displays the extent of the build-up area in a certain year. Lack of data can result in abrupt changes between the frames.

## Animation and successive build-up

Maps often represent complex processes that can be explained expressively by animation. To present the structure of a city, for example, animations can be used to show subsequent map layers that explain the logic of this structure (first relief, followed by hydrography, infrastructure, and land use, etc). Another example is a map showing population density in which alternating classes are highlighted to show for instance the distribution of low and high values. Throughout this type of animation, spatial data's temporal component is fixed, while location and/or attribute is/are plotted against display time. Changes in location or attribute take place and can affect each other.

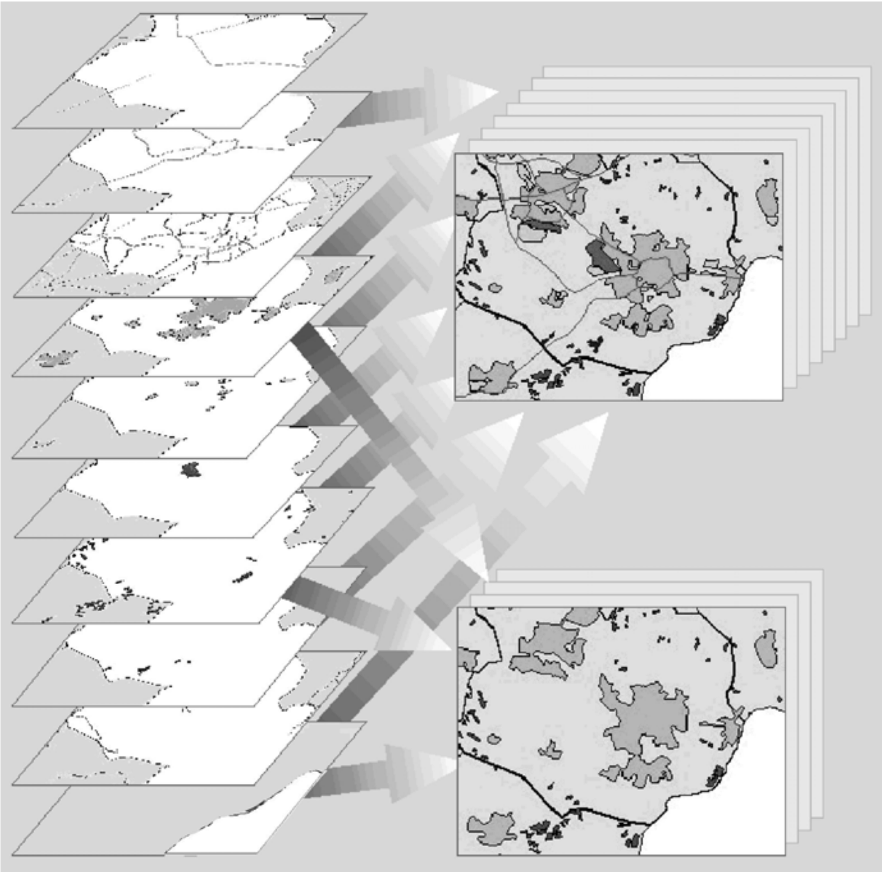

**Fig. 3.** Animation and successive build-up. Here a user has selected several layers from a database from the Twente region. The maps have been put in a sequence that can be played back and forward to get an understanding of the regions spatial patterns.

## Animation and changing representations

This type of animation offers the viewer an extensive look at a particular data set. In these animations, location, attribute and time are fixed. The same data are shown, but from a different graphic or classification perspective. Samples are the maps with blinking symbols to attract attention to a certain location or the simulated flights through a landscape that give the user a changing viewpoint on the landscape. Also an animation displaying quantitative maps based on different classification methods or to displaying the data set by changing the graphic representation belong into this category.


**Fig. 4.** Animation and changing representation. The change can be due to data or graphic manipulation. The fly-through of a mountain area in the south of France is represented here with two frames, and is an example of the last category. To create the animation the user can define a path in a map and set the distance between the locations in the landscape where the subsequent frames will be generated.

## 22.3 Cartographic animation environment and visualization strategies

What should be the environment where each of the above mentioned type of animation can be used? Aspects to consider in the user environment are the interface, the design of the map image, the legend and a link with the database. The environment to create the animation will not be examined here. But, it should be realised that in an exploratory environment the producer of the animation is the same person as the user. Animation is being used to provide a better insight by the person trying to understand particular geographic phenomena. It can be imagined that in such cases the animation is created based on queries to a database.

### Interface

For the user of a cartographic animation, it is important to have tools available that allow for interaction while viewing the animation. Seeing the animation play will often leave users with many questions of what they have seen. Just a re-play is not sufficient to answers questions like 'What was the position of the coastline in the north during the 15th century?' Most general software to view animations already offer facilities such as 'pause', to look at a particular frame, and '(fast-) forward' and '(fast-) backward', to go to a particular frame. More options have to be added, such as a possibility to directly go to a certain frame based on for instance a temporal query, or the ability to re-ordering individual frames based on a attribute query. Both options require a direct link with the database. This becomes especially relevant if we realise that animation will not only be used to present spatial data, but will be increasingly used in an exploratory environment. In such an environment the animation is just one of the alternative view one has available to study the data at hand (Dykes et al., 2005).

### Map image

Maps in an animation are not necessarily different from any other maps. But because of performance reasons most animation will cover only part of a screen and as such are small in size. This might have implication on the information content of the map, since animation maps also have the task to inform (DiBiase et al., 1992; Harrower, 2003)).

### Legend

Just as any other map, an animated display also need a to explain the meaning of the map symbols. However, the legend can have a dual function. Besides being a tool for explanation it can be a tool for navigation. In a temporal animation it can let the user travel through time. In an animation which frames are ordered based on attribute values, it allows one to travel from high to low values. A 2D-index map with a 3D flyby gives the users the option to move to any position in the flyby and start or continue their trip. The combination of legend as an interpretation device and an interface control tool allows the user to answer far more interesting questions then just looking at the frames passing by ((Kraak et al., 1997)).

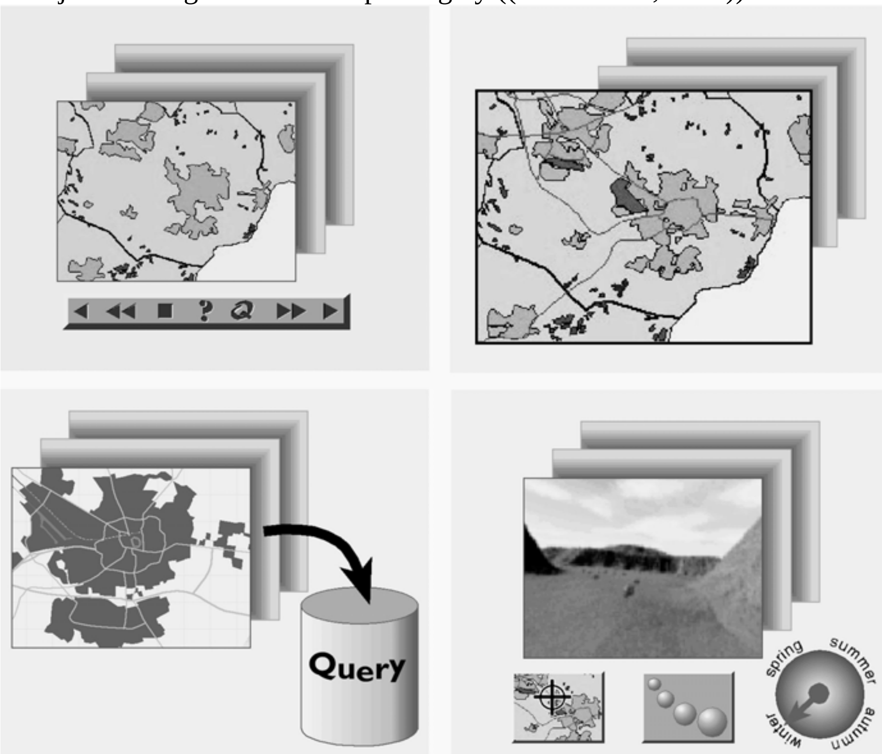


**Fig. 5.** Cartographic animation environment. The diagram shows the most important features of the user environment: upper left: the interface to move through the animation; upper right: the map image showing spatial pattern; lower right: the legend for navigation and explanation; lower left: the link with the database to query the map images.

## Link to database

The link between the database and the animation seems to be a necessity. The extent of this link, however, depends on the visualization strategy (e.g. presentation vs. exploration). In an exploratory environment, querying the database ideally should produce the animation, and provide the user with access to the animation from any point in the animation. For some presentation purposes, such as the daily weather report, it is less relevant.

## 22.4 Conclusions

Animation offers the user the opportunity to see and query changes spatial patterns. Depending on the nature of the data one can apply different design techniques, or change the viewpoint on the data. Animation will offer a better insight to mapped phenomena. However, this will only work when the user environment has the proper options for interaction. In an exploratory environment the animation will be one of the strong alterative views on the data that supports knowledge discovery.

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