

## Cartographic Animation in Interactive Mapping Environments – A Multimedia Approach to Dynamic Geodata Visualization

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As graphic representations of spatial data models, maps visualize a wide variety of geographic information. Especially since earth observation satellites have made available large amounts of multitemporal environmental data, geoscientists are able to study not only the spatial but also the temporal dimensions of dynamic processes. Effective representation of these spatio-temporal data with map models requires adequate cartographic transformation of time. In conventional mapping, map modelling has focussed on the single "optimal" paper map employing graphic symbols for the depiction of spatial and thematic data. Methodically, the cartographic representation of temporal or dynamic attributes by means of static symbols is problematic, and for this reason the representation of time and movement has been identified one of the major unsolved problems of thematic cartography. Consequently, the dimensions of space-related time and movement have explicitly been excluded from the system of graphic variables. With a limited number of noteworthy exceptions, cartographic displays of geographic information thus depict static views of our changing environment.

Instead, visualization of the temporal and dynamic features of spatial data has been assigned to non-static cinematographic tools outside the graphic system. Closely linked to the development of cinematography, animation is a traditional technique which can and has been used to visualize the spatial as well as the temporal dimensions of geographic information. In animated mapping, the dimensions of time and dynamics of spatial data can be broken down to the elements of duration, change, and phase, reflecting changes in the existence, location, and attributes of geographic objects over time. Employing conventional mapping techniques, animated maps had to be created in a time-consuming procedure by constructing a multitude of slightly different map frames put together in flipbook-style map movies of a few seconds. In the age of automated cartography, computing and information technologies have made multimedia applications, including interactive mapping a reality, providing both powerful and cost-effective tools for the multidimensional representation and exploration of space-related time and movement. Computer-based cartographic animation can thus make full use of state-of-the-art animation techniques ranging from basic frame-by-frame animation and interbetweening to sophisticated on-the-fly animation of interactively selected data sets.

Integrating animation into interactive mapping environments provides the possibility of user-defined interactive manipulation of spatio-temporal data sets. Promoting multiple-perspective visualization of geodata, animated interactive mapping is breaking cartography's restriction to single map solutions. In this paper, the cartographic potential of animation in interactive mapping environments will be discussed with regard to the adequate visualization of dynamic processes. Interactive map animations of climatic and statistical data will be presented to illustrate findings from an interactive animation R&D project, evidencing that animation can be employed as an effective modelling concept to depict the temporal dimensions of dynamic spatial processes.