Chapter 11
Making the Unseen Visible:
The Art of Visualization

ABSTRACT

Themes and examples examined in this chapter discuss the fast growing field of visualization. First, basic terms: data, information, knowledge, dimensions, and variables are discussed before going into the visualization issues. The next part of the text overviews some of the basics in visualization techniques: data-, information-, and knowledge-visualization, and tells about tools and techniques used in visualization such as data mining, clusters and biclustering, concept mapping, knowledge maps, network visualization, Web-search result visualization, open source intelligence, visualization of the Semantic Web, visual analytics, and tag cloud visualization. This is followed by some remarks on music visualization. The next part of the chapter is about the meaning and the role of visualization in various kinds of presentations. Discussion relates to concept visualization in visual learning, visualization in education, collaborative visualization, professions that employ visualization skills, and well-known examples of visualization that progress science. Comments on cultural heritage knowledge visualization conclude the chapter.

1. INTRODUCTION: FROM DATA TO PICTURES AND THEN TO INSIGHT

The following text examines the language of visualization (often conceived as cross disciplinary), the interactive culture of knowledge visualization, and comprises some notes about the visual content analysis applied to data and knowledge. Art, graphic design, visual storytelling, and the use of signs support visual communication of human insight and understanding. As Rudolf Arnheim (n.d.) put it, "All perceiving is also thinking, all reasoning is also intuition, all observation is also invention." Visualization uses visual imagery and visual thinking to understand complex information, therefore it differs from a metaphor or

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analogy. Through creating symbols, meaning can be conveyed and expressed by means of images. Graphs, diagrams, and animations can visualize messages as well. As productive thinking in whatever area of cognition takes place in the realm of imagery, visual perception should be considered a cognitive activity. In his structure of intellect model, Joy Paul Guilford (1968) designated a single factor as the cognition of visual figural systems. Visualization has also been considered a semiotic process because of the use of signs to present ideas. One may say visualization meant in traditional terms the intuitive use of a visual presentation of a concept; one of the most often cited examples is August Kekulé's vision of dancing atoms and molecules telling about a structure of benzene. In general non-technological terms, visualization means a mental image that is similar to a visual perception. It is also the technique of creating a mental image of a desired outcome, and repeatedly playing that image in the mind. It is sometimes used in conjunction with medical treatment, including cancer treatment.

There are several approaches to the concept of visualization and the ways it mediates between the user and the physical world. Data is seen as an essential abstract concept from which further levels can be derived: information, and then knowledge. The most important domains in visualization can be seen as data visualization, information visualization, and knowledge visualization. Scientific visualization is another approach to visualization, where physically based data are selected, transformed, and represented according to space coordinates, for example, visualizing computer tomography data for medical use. In broadcast media, visualization techniques are often used to explain a process that is important for action development; for example, in an American television medical drama House, M.D. dynamic visualizations show the interior of human organism.

Information is usually presented in numerical, graphic, or diagrammatic form. When expressed as visualization, information may be shown as a sketch, drawing, diagram, plan, outline, image, geometric relationship, map, music and dance notation, object, interactive installation, or a story. Diagrams visualize information in a pictorial yet abstract (rather than illustrative) way, as plots, line graphs and charts, or the engineers' or architects' blueprints. Big and complicated presentations of data organization and interpretation, for example governmental statistics, are easier to comprehend in a graphic than in a numerical form, when they serve as explanatory tools for the data sets. Data provide us a raw material that has no meaning if we do not process it, so it becomes useful for our own purpose. We may find online visual presentations, for example "The crisis of credit cards visualized" (www.crisisofcredit.com) created by Jonathan Jarvis or "Wind map" (file://localhost/Users/ursyn/Desktop/Wind%20Map.html), a personal art project interactively showing the actual tracery of winds.

Graphic presentation shows how something works or explains the relationship between the parts of a whole. However, surfing the web, data mining, and manipulating the data are easier when the data is shown with the use of information visualization and interactive techniques, with more dimensions in a presentation. Data-, information-, and knowledge-visualization have been present in different disciplines and in various modes since early days of civilization. Visualizations of many kinds are powerful cognitive tools useful in our everyday life; they take their form from several domains, and so there are no defined boundaries between the different disciplines of visualization.

Essential terms: data, information, and knowledge may need some consideration before discussing the data-, information-, and knowledge visualization issues.