Multiple representations of navigable worlds

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INTRODUCTION: DESIGN METHOD

Our work focuses on the design of visualization and interaction techniques for large information spaces. Our design approach is based on a conceptual study of users and their tasks [4]. To face the diversity of users and tasks we adopt an interaction-centered approach and focus on navigation tasks. Based on the characteristics of navigation, we develop ergonomic criteria that need to be satisfied by the designed navigational techniques. One of the criteria, representation multiplicity, is crucial in order to accommodate the diversity of needs. We illustrate representation multiplicity with our own system, VITESSE [7, 10] that runs on the WWW. In the design method, the last step before coding, is software architecture modeling. In the context of VITESSE, we demonstrate the suitability of our architectural model PAC-AMODEUS for representation multiplicity.

CHARACTERISTICS OF NAVIGATION AND ERGONOMIC CRITERIA

Figure 1 shows our framework to characterize navigation. It underlines the spatial activities involved in navigation. Additionally the time dimension has also been shown to be crucial [3]. Space and time strategies define intertwined characteristics involved in navigation.

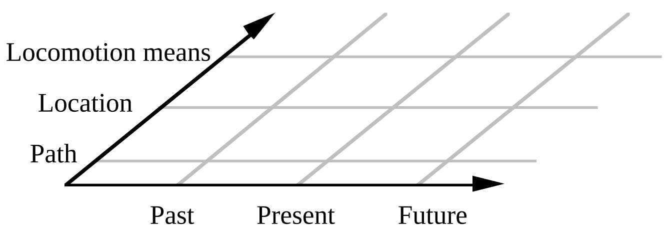

Figure 1: A framework to characterize navigation.

In [1] we provide a structured classification of ergonomic criteria to guide the design of interactive systems. Based on our framework to characterize navigation, we selected the ergonomic criteria that should be verified by the designed navigational techniques. One of the criteria is representation multiplicity.

REPRESENTATION MULTIPLICITY

Representation multiplicity involves flexibility of information space rendering in order to face the diversity of user's characteristics and tasks. Multiple representations better support different tasks. Representation multiplicity relies on output multimodality: In [5, 6] we define a modality as the coupling of a physical device d with a representational system r: <d, r>. Here we illustrate output multimodality using the same device (i.e., the screen) and multiple representations of the navigational space. Representation multiplicity must be distinguished from "interactive" externalizations [8] in which features of the data are made salient as and when required ("filtering" approach). Representation multiplicity and "interactive" externalizations are two complementary approaches for facing the diversity of user's tasks. Based on the characteristics of navigation, we developed three design rules related to the representation multiplicity criterion:

R1. Easy to change visualization.
R2. Continuity while changing visualization.
R3. Reusability of the navigational tools.

THE VITESSE SYSTEM: Visualizing the World Wide Web

As shown in Figure 2, VITESSE visualizes the results of a query submitted to a search engine on the WWW. Figure 3 illustrates the representation multiplicity criterion in VITESSE. The user can freely switch from one visualization to another one (R1). Animation is computed to guarantee visual continuity between views (R2) and the same navigational tools are provided at any time (R3).

The definition of a view is based on the following distortion function d [2]:

$$d(x) = x\frac{\sqrt{(x^2+z^2)(r^2-(z-o)^2)+z^2(z-o)^2}+z(z-o)}{x^2+z^2}$$

The viewing algorithm handles planar and/or polar transformations on both the X and Y-axes. Transformations can be d, as defined above, d^{-1} (transformation reciprocal) or a combination of functions.

We applied the PAC-Amodeus software architecture model for the software design of VITESSE. In [9], we show how to verify the three design rules of the representation multiplicity criterion within the PAC-Amodeus components.

CURRENT WORK

We are currently preparing experiments for evaluating the multiple representations. We will evaluate the VITESSE system based on particular scenarios. The independent variables or factors of the experimental design are the multiple views. The experiment will be carried out on the WWW using CGI scripts to capture user's events.

In one research avenue we will further exploit output multimodality to enhance visualization and navigation. Multiple representation is one case of multimodality using one output physical device (i.e., the screen). We envision the use of different output modalities (both multiple representations and devices). For example in VITESSE we are developing dynamic sonic landmarks: sonic landmarks vary according to the focus of the user.

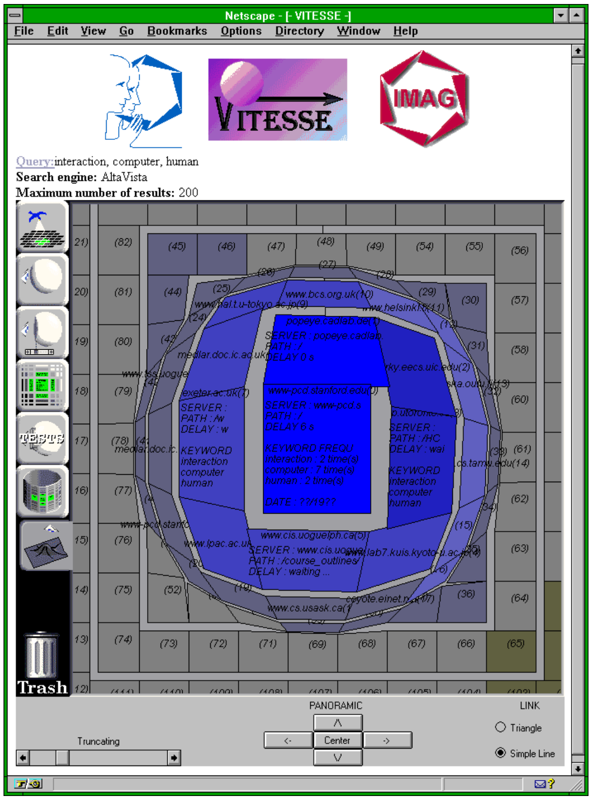

Figure 2: A snapshot from the VITESSE system.

CONTRIBUTION TO THE WORKSHOP

To provide a better understanding of the following:

- Design method of visualization techniques and interaction techniques.
- Ergonomic criteria of interaction techniques.
- Multimodality (design spaces and software architecture models).
- Representation multiplicity of large information spaces and its software architecture.

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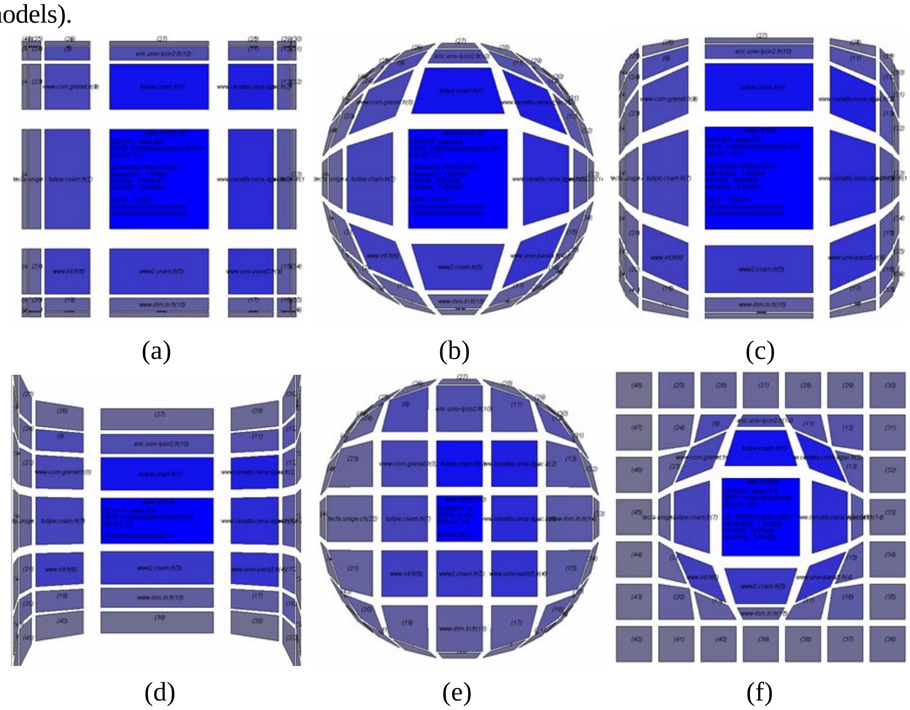

Figure 3: Representation multiplicity of the information space in VITESSE. (a) Planar transformation (b) Polar transformation (c) Planar transformation on the X-axis and polar transformation on the Y-axis (d) Planar transformation on the X-axis and reciprocal polar transformation on the Y-axis (e, f) Combinations of distortion functions.