INFORMOTION

Dynamic Representation of Information Structures

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Abstract. Information is everywhere. We are flooded by information and one can observe peoples problems handling the amount of information. The relational table as the mean to present information as well as simple html pages are having their obvious depts. Therefore, people are looking into three-dimensional representations and entire virtual environments to visualize data contents.

Within this papers it is proposed to visualize information and information structures in a dynamic fashion. Therefore, we will have a look at some principles of dynamic representations as well as the metaphors and methods used to enables dynamic representations. With *Autonomous Objects* in Sculptor and *inforMotion* two examples are implemented in our research projects using dynamic data visualization.

1. Introduction

The goal of the research project *Information, Communication and Cooperation in the Swiss AEC industry ICCS* (Stouffs 1998) is to deal with all the information and communication in the building process. We are developing interfaces to store all the data of one project in one database. Text, construction files, design sketches, contract, publications, memos, images, email, web links etc. are managed by this web-based site to enable the formation of virtual companies.

The major problem using the interface however is to organize the data, how to store information on it and how to find the information again. The conventional way to do it are common standards: Standards how to name file, standards for hierarchical structures. However, this approach is very limited regarding presentation of information.

Additionally, we are looking into different ways to present data to the user. Data not as an isolated entity but as a part of highly connected information structures. Data entities have their relations to other data, their references, versions, creators sources etc. There are hard-coded connections between data entities within a database. However, other connections of interest that have to be created by a smart interface. All this types of connections have to be visualized to enable understanding of the complex structures of data. This would enable users to find information and be informed about data related to their work.

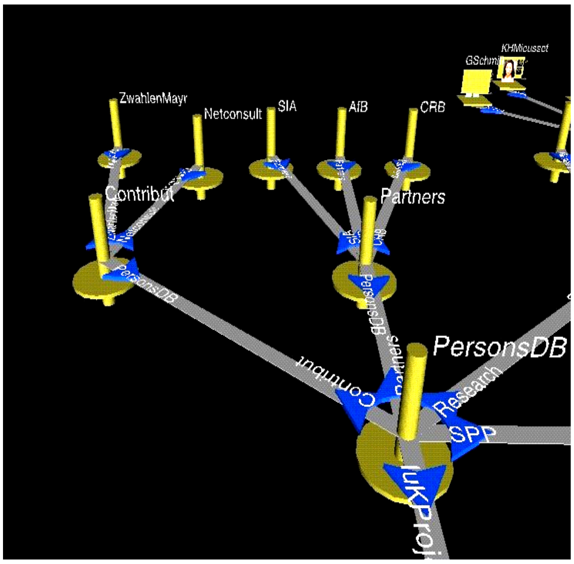

Figure 1. A visual representation of the ICCS project team members.
It enables driving trough a VRML model of database content.

To visualize these multi-dimensional information structures one could use structures that change in time in order to emphasize different types of connections found by the system. A constantly changing representation enables an understanding of a complex structure. Similar idea also formulated in other fields is very relevant in the field of architecture and engineering as well. Even more: with the knowledge of designing in three dimensions, architects can contribute to the field of data representation in general.

One might not notice it but the trend is clear: Information is being stored in *databases* in one or the other way. This goes along with a change of the database paradigm. It is not just the storage and retrieval of data that is of importance but the representation of it. The ability of showing relations rather than the recording of facts. Databases are omni-present: Every up-to-date computer operating system is maintaining a database for all the files on a hard disc including information about file positions, types, display mode, dates etc. Increasingly also web sites are driven by databases that contain the information and are composing the actual content of a page on remote request. One could say without exaggeration that the entire World Wide Web is a huge database of linked information. The information is being stored somewhere - one has to retrieve it and present it to the users. Therefore, it's about presenting the information to the users - or to be precise about re-present it.

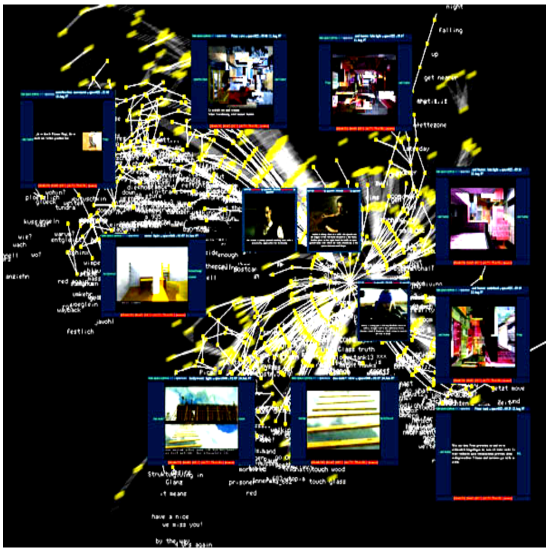

Figure 2. fake.space is showing the beauty data visualization. F. Gramazio (Hirschberg, 1998)

Information

Talking of information representations it is important to talk about the inherent *structure* of all related information. What type for information are we talking about - is there something like a general way of representing data or does every structure needs its own type of visualization?

One has to distinguish between the interaction with information, the search in data and the visualization to get an overview or to navigate in information. Quite often, there is a hierarchical structure inherent or the information organized as a flat type of net both highly and loosely connected (hyperlinks). Often also the information is weighted in one way or the other meaning parts of the information are more important then others.

An issue being very important but not appreciated enough is the distinction between different *type of relation* between objects. Thinking of the World Wide Web there is only one possible relation type: the hyperlinks only define a very limited, one-dimensional and directed one. How often one hasn't wished to be able to recall where a document was referenced - at least bi-directional links would be nice. Looking more deeply into the topic of relations in regard to their presentation one sees many more possibilities how the connection between two ore more objects could be helpful to understand related information. Different types of connections would be very helpful.

In the ICCS research project, we were implementing a traditional type of database putting in all data about a building project. There are types of data entries stored in tables like: project leaders, contractor, address, construction drawings, text files, images etc. Until now, the relations are done the conventional way. Now we are thinking about changing this and naming the relations between data as well. This would enable us to show dependencies much easier; who did what when according to which documents.

Virtual environments

Representing and interacting with information is tightly connected to the history of computer. A multitude of research is going on in the fields of human-machine-interfaces, user interaction, information architecture but also cognitive issues as metaphors, mind mapping and many more.

As graphics ability of computers are improving recently there is also the need for three-dimensional representations. Tools are available PC's to view and manipulate virtual environments (VE) of reality-based models as well as representations of data structures and information contents in an abstract sense.
Especially visualizing large entities of data is the mayor endeavor for data visualization. Very often, this is done by combining images and text i.e. combining three-dimensional close-to-reality data and two-dimensional Information enhancement. (Lokuge and Ishizaki, 1995)

Of quite an importance is the influence of architecture on these types of visualizations. Kevin Lynch presented in *The Image of the City* (1960) the necessary elements for the perception of the city. Path's, edges, districts, nodes and landmarks are widely used in VE's as essential elements for abstracts models (see *Fig. 1*).

Among many interesting developments being done in this area is the tool "Wombat" (Strong et al, 1998). The author uses the principles of mind mapping and cognitive perception to place his VE in the context of the Australian bush, as a view of an animal. The user is controlling video segments move along in the VE.

Dynamic Representations

We therefore propose to expand the representation of information to become dynamic - which means to add a motion of object as well as a change of the representation in time. It is about building tools for displaying complex information by flattening multi-dimensional structures displayed linear in time. One could overcome the limitations of three-dimensional structures very easily that way. More than just another dimension the introduction of liquid dynamic representations offer a splitting up of complexity in time to evade limitations of three-dimensional representations in virtual environments. Another advantage of this type of presentations would be that navigation is much easier and there is no reload of pages necessary. Of course not all the nodes and relations are visible at the same time.

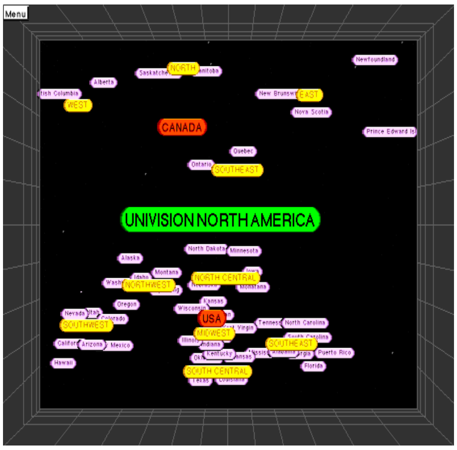

Figure 3. HotSauce™ developed by Apple Computers allows flying through a virtual environment driven by a web-site.

An essential element of dynamic representation is the *activity* of the dynamic behavior of objects and scenes in information representations. This offers many possibilities to present attributes of data: importance, action required, rapidness of data change etc. The intensity, the frequency of the motion as well as size and synchronicity enable the characterization of objects and scenes additional to the geometrical modeling like density and connectivity, form and color.

Figure 4. Visual Thesaurus by Plumb Design

A very nice and inspiring example of dynamic data visualization going one step further than HotSauce (Fig. 3) is the Visual Thesaurus. "An engaging experience in language and interface, the Plumb Design Visual Thesaurus is an artistic exploration that is also a learning tool" as they see it themselves (Plumb Design 1999). Written in Java this tool is allowing users to visualize the relationships of language interactively having words and relations of them visible in perpetual motion.

Project 1: Sculptor: Autonomous Motion

The combination of a 3d modeling program and dynamic data representation is realized in our design tool called Sculptor, a computer tool for virtual design in architecture (Kurmann, 1998). Sculptor allows direct, intuitive and immersive access to three-dimensional design models. Through this interactive modeling in a virtual space, an easy way of generating and manipulating models and scenes is made possible. The prototype supports interactive parameter specification of objects, models and scenes with attributes like form, geometry, color, material, etc. Objects, groups and virtual worlds can be changed in real-time by scaling, resizing, rotating, reshaping and moving them in space.

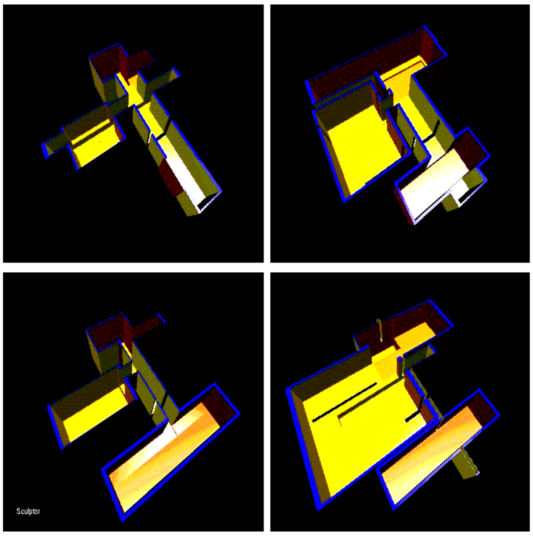

Figure 5. A sequence of images showing the autonomous moving rooms in Sculptor

The dynamic aspects of representation are done with autonomous motion and transformation for liquid scenes. To every object a certain form, intensity and speed of motion can be attached. This behavior adds a new complexity to a scene and allows the creation of liquid architecture. Therefore, Objects not only have a position and color but also a dynamic behavior in time which makes them change constantly. Since the parameters can be changed for every object or group separately, very complex scenes in time can be created. This behavior adds realism to an existing static scene and can be used to attract the attention by vibrating objects.

The experiments with autonomous motion to develop design solutions work very efficiently and surprisingly. Each object has certain properties and a model of behavior attached with it. A user can activate certain principles such as the gravity or collision detection, and make certain objects move dynamically in three-dimensional space. At each moment, the virtual design worlds evolve according to the forces that are active and which guide the growth of objects. A typical sequence shows a range of valid solutions. At any moment, the user is able to stop the motion, intervene and change the course of modeling - a mechanism we call the 'I Like It'-principle. A liquid architecture can be defined which for some user might be a possible source of inspiration, for others an annoying and useless thing. It might be a part of creativity, a principle very hard to support in computer tools.

Figure 6. A sequence of snapshots shows *inforMotion* representing data of our CAAD web site dynamically.

Project 2: inforMotion applied in the IuK project

This proposal is neither using direct cognitive mind mapping nor is it using existing metaphors of existing virtual environments or interface. inforMotion is presenting multi-dimensional information in perpetual motion. Enables the viewer to navigate through complex information and explore relationships. We have noticed, the animated representations in fact are highly responsive. They encourage the user to interact with the tool. They'll start to move the mouse which makes the representation change instantly: The node under the mouse pointers becomes the center of information and the other elements are arranging themselves according to the relation selected. Non relevant data is vanishing, new data relevant is appearing. Clicking on objects is not needed.

Objects are acting based on the laws of physics. Nodes are both attracted by the causing information node and repelled from the one's on the same level of hierarchy. This causes them to act magnet like and arrange themselves autonomously around related information but at the same time being readable most of the time. Therefore, there is not one ideal position of an object but the nodes are rearranging themselves constantly. The rapidity of change the change is determined by the distance.

In contrast to Visual Thesaurus inforMotion is not showing relations as lines explicitly. It is concentrating on showing dependencies as groups in a hierarchical way in multiple layers using principles of levels of detail. More like an overview of related information than a explicit relations of them.

InforMotion is written in JavaScript and DHTML, using textual information (Small et al., 1994) on layers. Data is retrieved from a Database using SQL queries.

Conclusion

I wanted to show more than yet another type of representation with this paper. Dynamic visualization is intended to display multi-dimensional information content and information relations to enables people to overlook data entities and to overcome dimensional boundaries. Moreover, I am convinced that these implementations done for a research project will help people in praxis to understand data.

Acknowledgment

The ICCS project is research supported by the Swiss National Science Foundation. Working together with Dr. Rudi Stouffs, Bige Tunçer, Kuk Hwan Mieusset and Benjamin Staeger and headed by Prof. Dr. Gerhard Schmitt we are developing tool for the virtual company. See further results on: http://caad.arch.ethz.ch/research/iuk

Sculptor is being developed by the author within several projects supported by the Chair for Architecture and CAAD of ETH and the Swiss National Science Foundation. http://caad.arch.ethz.ch/~kurmann/sculptor

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