Collaborative Hypermedia in Virtual Reality Systems

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Introduction
The objective of this effort is to integrate aspects of technology from Computer Mediated Communications (CMC), Virtual Reality and Hypertext/Hypermedia to demonstrate a new potential to facilitate human communications via computer. This integration, we believe, will result in a new type of Collaborative Hypermedia System, one that can cure a number of significant usability and applicability problems that have plagued these technologies on an individual basis. These include lack of customization and information overload (Hiltz & Turoff, 1985).

CMC within the context of our research (Turoff, 1991; Hiltz & Turoff 1978, 1994; Linstone and Turoff, 1975) has always meant the creation of computer based communication structures and procedures which are tailored to the nature of the application and the nature of the group in order to find the most effective means for each user to understand the current group results and to facilitate individual participation in the discussion. Today most of the widespread commercial examples of this application area have been limited to only a few specific implementations (such as "electronic mail") with little ability to demonstrate a wide range of communication structures and protocol tailoring in a single system. Finally, what tailoring is available is usually beyond the control of the actual users.

Consider that with CMC (Hiltz & Turoff, 1993), even small groups of people working together on a complex problem can generate thousands of comments in the space of a few months. In CMC, information overload by collaborative groups has always been a fundamental problem (Hiltz & Turoff, 1985).

There is not any real difference between the problems of a collaborative Hypertext System and a CMC System. Many investigations of Hypertext (Conklin, 1987; Garzotto et. al., 1995; Thuering, et. al. 1995) have exposed the problem of getting lost in complex webs of material and this is fundamentally the same problem as information overload in CMC systems. Every CMC system has had an internal specialized linkage structure for ordering discussions. What is needed is a concept of Hypertext/Hypermedia that is much closer to the original dream that Bush (1945), Nelson (1965) and others (Turoff, 1977) had than the current commercially available products. In those views it was a system to create and integrate knowledge, not to just retrieve it.

Group Communications
Groups that work together on a regular basis convert ambiguity in terms and concepts to very specific meanings, and invent new terms and acronyms. Groups that collaborate
must be able to impose a shared view, application specific understandings and meanings, and their own evolving collaborative organizing approaches on a CMC System or a Collaborative Hypertext system. The ability of a medium to allow this to occur in an effective manner has been termed "media richness" (Daft & Lengel, 1986). The accusation made by Daft & Lengel in their classic article is that computer based communications can never provide media richness and will never be useful for true management problems. It is our position that a Collaborative Hypermedia System can show Daft's proposition to be incorrect.

Developing shared views results over time through the collaborative communications process. We seek to allow groups to arrive at collaborative and explicit mental models for complex problems. As educators, a significant part of the knowledge we attempt to convey to learners is the problem conceptualization and problem solving cognitive processes. We are teaching a way of thinking, a thought process. Even in a technical course, it is not the finished solution to an analysis problem or the expression of a derived formula that is important. Rather, it is the thinking process that allows a person to derive a result or solve a problem, and the collection of individual steps or the expression of the thinking process. One does not learn to paint by looking at a finished painting but by observing a good artist execute the actual process of creating the painting. The design of a product (a building, a bridge, or a software system) involves specialized design processes that the experts have acquired from years of experience. We fundamentally rely on the concept of Hypertext as a means of authoring the non-linear relationships of a thinking process more directly (Turoff, et. al., 1991; Conklin, 1997). Furthermore, as a learning device we can use the non-linear thought structures in a Hypertext semantic representation to be a mechanism for those that are less expert in a given problem domain to learn from those that are more expert in that domain.

**Approach**

Recently there has become available software that supports the creation of Virtual Worlds through the WEB. These are object oriented systems that allow people to use objects that have been defined for the world, to individually create their own, and to develop their own virtual environment with its own look and interaction rules (e.g. Alphaworld, at http://www.worlds.net). Objects are identified by who has created the given instance and other users cannot modify these unless they have special privileges usually reserved for those administering the world. People use "avatars" to move around the world and there is a master memory of the world so it may be used in an asynchronous or a synchronous manner by groups. This software and its three dimensional VR capabilities could alleviate many of the difficulties holding back the advancement of CMC and Collaborative Hypertext systems.

Given an appropriate discourse structure expressed as a Hypertext template, our model is a Virtual World where individuals working as a group use the constructs (semantic typed nodes and links) to contribute to the discourse and build a resulting three dimensional representation of the collective group discussion. This semantic template serves to guide the discussion as to what contributions are allowed in an analogous, but application
specific, approach to that of "Roberts Rules of Order" for large face to face groups. Such a construction would take on a shape analogous to a large evolving organic molecule (the exact metaphor to use is still being hotly debated) based upon utilizing an erector set of tools.

The work of Hopkins (1987) indicates a direct correlation between the complexity of a model's structure and the expertise of the person defining the structure of the model. This has tremendous implications for collaborative problem solving if we can devise better processes where individuals can work collaboratively to build complex structural models of a situation (Lendaris, 1980; Warfield 1974). This also leads to new ways to evaluating the quality of collaborative efforts dealing with complex problems.

In what follows we illustrate one possible visualization of a complex discussion, e.g., among military or business planners. Conducting this discussion in a 3D world could give these planners a new suite of tools and representations for organizing and comprehending the overall growth, status and context of the discussion.

Examples

An early Delphi structure was the Policy Delphi (Turoff, 1972) which relates to the ideas of a Hegelian Inquiry Process (Churchman, 1971). Versions of this have occurred in the literature of software development as dialectic requirement formulation structures (e.g. gIBIS), (Conklin & Begeman, 1989). In essence these are structures to organize a constructive debate about a topic and the results sought are collective group insights into such things as desirable policy resolutions, feasible actions to take, and important software requirements. Such a group communication activity can be specified by a semantic Hypertext structure as shown in Figure 1.

![Figure 1: A Discourse Structure for Debating and Argumentation](image)

In a typical debate a member can enter a proposition which in different applications can be such things as actions, goals, solutions, decisions, etc.. Any other member can enter either a pro or con argument associated with one or more of the proposition nodes with either pro or con links. Certain arguments might be further linked together by being in opposition to one another. Anyone can vote for the degree of desirability and feasibility of each offered resolution (actions, decisions, etc.) and relative importance and validity of each argument. These are the only things that a member of the collaborative group is
allowed to do and no discussion is allowed that does not fit the above discourse structure. However, they may change their earlier views and votes at any time.

In the three dimensional world let us imagine something akin to a complex organic molecule that results in a three dimensional construction. There are two types of nodes or atoms, the resolutions and the arguments; and there are three types of links or relationships: pro, con, and opposition. Any member of the group may add to the collaborative construction using these building modules. The actual contents of a node can be explicit and/or linked via HTML to material elsewhere.

Note that there are four collaborative dimensions associated with the material: Desirability, Feasibility, Importance, and Validity. To provide greater understanding of the discussion, these could be used to dynamically reorder the spatial dimensions of this material as viewed by the individuals such as illustrated in Figure 2. For example, each of the four scales are finite (-1 to +1) interval scales and visualized as the side of two buildings. One building houses arguments with the importance and validity voting distribution scales as two of its dimensions: importance and validity. The other building houses solutions with its two sides representing the desirability and feasibility distribution scales. The third dimension (a wall) is shared and represents the proportion of the eligible votes that have been cast. Until a voting threshold (sufficient minimum number of votes) is obtained, new solutions or arguments lie on the ground in the accompanying yard of construction materials. Links are represented as rubber bands. One can organize lists based upon links to get linear relationships and views of the discussion or utilize the links to view only various subgraph constructs of the discussion structure.

While the debating structure seems rather simple and straightforward, consider a very common planning structure used in many successful corporate planning Delphi exercises. One starts with a trend which could be highly quantitative such as the amount of a product's sales over the past five years, or it could be semi subjective, such as the number of terrorist type bombings in the U.S. (realizing that unsolved acts might or might not be judged in this category). The participants are asked to make a forecast for the trend and to indicate the assumptions they are making about the future that will influence the trend, Figure 3. They are also

![Figure 2: A Possible Voting Construction](image-url)

**Figure 2: A Possible Voting Construction**

*Three Dimensional Representation*
asked to express any uncertainties (i.e., things they don't think will occur but which would change the projection if they did). All these are taken as potential assumptions which the group votes on for degree of validity. The validity vote is used to rate all the assumptions into an interval scale and to distinguish three basic categories: Very likely, Very unlikely, and uncertain. It is the uncertain ones that are focused upon to further distinguish between those that can be controlled by actions the organization can take and those that can not be influenced by actions that can be taken. In some cases it is important to explore how to measure or observe whether an assumption has come true (e.g. the development of a new military system or competitors product).

Note that these action nodes are exactly what starts the debating structure and the two structures are really now one combined structure. There are many such discourse structures (Linstone & Turoff, 1975) that combine to more complex structures and as such represent a potential toolkit for collaborative Hypertext. Currently we are working on a structure for the design of interfaces (Balasubramanian & Turoff, 1995, 1996) that has 17 typed semantic nodes and 39 typed semantic links. This is first being evaluated in a current thesis effort as an aid to the creative phase of the design process for designers and to aid in capturing the design rationale. Our second effort will be to evaluate it as a discourse structure between users and designers for the development of the functional requirements. The more specific the problem domain and the greater the expertise of the members of the group, the richer the discourse structure necessary for problem solving becomes.

**Objectives and Conclusions**

Our objective is to create a library of objects and group scaling methods that will allow us to experiment with different discourse structures and the associated scaling methods to allow dynamic three dimensional constructions to foster collaborative understandings and outcomes. The illustrations in this example are only one such structure.

The above are only examples of possible semantic Hypertext templates (Turoff, Rao, Hiltz, 1991; Catlin, et. al., 1989) and associated voting structure. The specification of a given semantic template (semantic node and link structure) and the choice of voting scales, their scaling and the resulting dimensional displays has to be a process tailorable to any specific type of problem domain and to the nature of the group (learners, experts, negotiating, homogenous, heterogeneous, etc.).

The most challenging aspect of research with groups is the gaining of an understanding of process and the associated discourse. The methodologies offered by the state of the art at best employ narrowly focused coding schemes for finding behavioral (speech-act) patterns in recorded (text/video/audio) group proceedings, and at worst rely on averages of subjective perceptions of group members. The construction of 3D virtual spaces, where group members and the researchers have the ability to visualize and record/track the movement of semantic constructs along subjective assessment dimensions will be a major advancement in the realm of research methodologies and tools available to behavioral scientists.
The ability to create 3D virtual worlds over the Web is a recent development. Collaborative construction of representations of the real world from granular 3D multimedia objects over the Web is potentially exciting. It enables humans to utilize their creative talents with relative ease, and at the same time, provides an audience for the appreciation of their work. We believe this will be an ideal environment to motivate subjects to participate and to do their best work.

We believe that a 3D object environment would provide a powerful mechanism for enhancement of understanding among group members and facilitate the process of equivocality reduction. The challenge has been made in the management literature that Information Systems can never be used to deal with "real" management problems because of the lack of media richness and the problem of dealing with equivocality (Daft & Lengel, 1986). We are talking about a system designed to deal with subjective views, opinions, and estimations and utilizing new techniques to promote common understandings among the group members. As a result we believe we can show the position in the Daft and Lengel paper, as well as that taken by many other Management Scientists, to be largely incorrect.

References

Bush, V. (1945), As We May Think, Atlantic Monthly, 176, 101-108.