WebGrid: Knowledge Elicitation and Modeling on the Web

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Abstract: This article reports on experience in moving a highly interactive application, that of repertory grid elicitation and modeling, from personal computers to World Wide Web servers to make it widely available on a platform-independent basis. Repertory grid elicitation is a knowledge acquisition technique developed in personal construct psychology that supports the development of conceptual models by eliciting the distinctions made by individuals construing a domain. It is widely used in clinical psychology, education, management and knowledge-based system development. This article illustrates repertory grid elicitation and modeling over the web in a personal decision making domain, that of selecting a home from those offered by a realtor.

1 Introduction

Repertory grid elicitation is a knowledge acquisition technique developed in personal construct psychology (PCP) that supports the development of conceptual models by eliciting the distinctions made by individuals construing a domain (Gaines and Shaw, 1993a). The technique uses concrete instances of elements relevant to the domain to provide an easily conceptualized environment for elicitation, and prompts the client with a range of questions about similarities and differences in the domain that lead to rapid elicitation of the distinctions made, and the terms used for them. Repertory grids were originally developed to elicit the conceptual models of clients undergoing psychotherapy (Kelly, 1955), but were rapidly found to be useful in a wide variety of applications in management, education and the development of knowledge-based systems (Shaw, 1980; Shaw, 1981).

The networking of personal workstations in the 1980s made it attractive to develop groupware knowledge acquisition and modeling techniques that made overt individual and social constructions in groups working together on local area networks (Shaw and Gaines, 1991; Shaw and Gaines, 1993). The advent of the World Wide Web in the 1990s make it feasible to move these techniques to the web, and make widely available techniques for conceptual modeling that can be used in their own right or integrated with other applications.

This article describes experience in moving repertory grid elicitation and analysis onto the World Wide Web. WebGrid is an HTTP server variant of our RepGrid program (CPCS, 1993), the repertory grid subsystem of KSSn, an integrated suite of knowledge support system tools (Gaines and Shaw, 1993a; Gaines, 1994). WebGrid allows any web client supporting HTML level 2.0 to be used for repertory grid elicitation and analysis.

Most examples of repertory grid elicitation focus on specialist professional applications. However, the tools are generally applicable to any kind of decision making situation, and the application used to illustrate WebGrid in this paper is that of home purchase, a common experience typical of individual and group decision making.

2 WebGrid in Action

The simplest way to understand WebGrid is to use it on the web (http://tiger.cpsc.ucalgary.ca/WebGrid/), and the next simplest is to see someone else using it. This section shows WebGrid in action in a real estate decision making application.

2.1 WebGrid Set Up

The scenario is that John and Mary are looking to purchase a new home and the realtor is having them use WebGrid to build a conceptual model of the dimensions on which they are evaluating the homes. Figure 1 shows the initial set up screen which enables the realtor to customize WebGrid by specifying the general domain, the specific context, the terms for elements, the terms for constructs, an initial set of elements, and header and trailer HTML for each page which will replace the normal WebGrid defaults. This set up need only be done once for a particular application area.

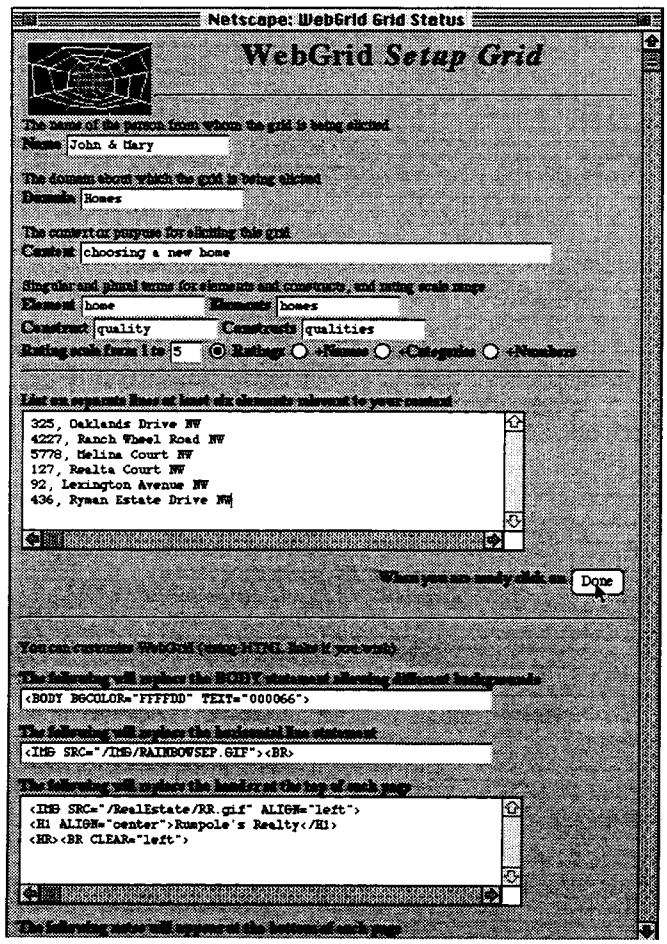

Figure 1 Initial form for setting up a WebGrid elicitation

The HTML in the header text area second from bottom replaces the WebGrid icon and heading with one specific to the realtor as shown in Figure 2, so that John and Mary see pages customized with a corporate image. The initial set of elements that the realtor has entered consists of 6 homes that she has already shown to John and Mary. She has used the annotation form shown in Figure 2 to enter notes on each property using stored photographs of the homes and the personal comments that John and Mary have made when viewing the homes.

2.2 WebGrid Triadic Elicitation Facilities

In practice, most of the customization of WebGrid, annotation of elements, and so on, in this type of application will be done through prestored forms and access to databases. The first screen that an end user sees is generally one of the form shown in Figure 3. This screen is generated by WebGrid using the standard repertory grid triadic elicitation technique of choosing 3 elements and asking in what way two are alike and different from the third. The user clicks in a radio button to select the one which is different, and types in his or her terms for the similarity and difference in the text boxes below. The similarity/difference define a distinction—they are the *poles* of a bipolar *construct* in Kelly's terminology.

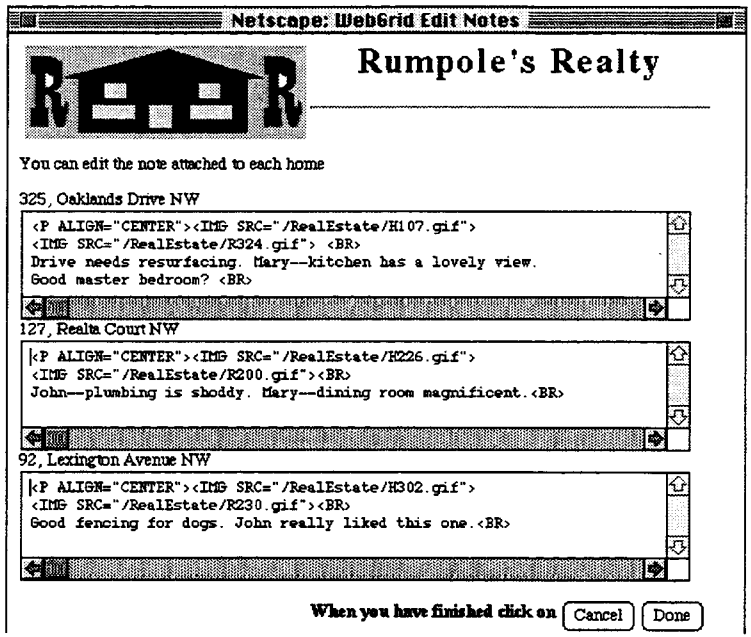

Figure 2 Annotating the elements with links to pictures and notes

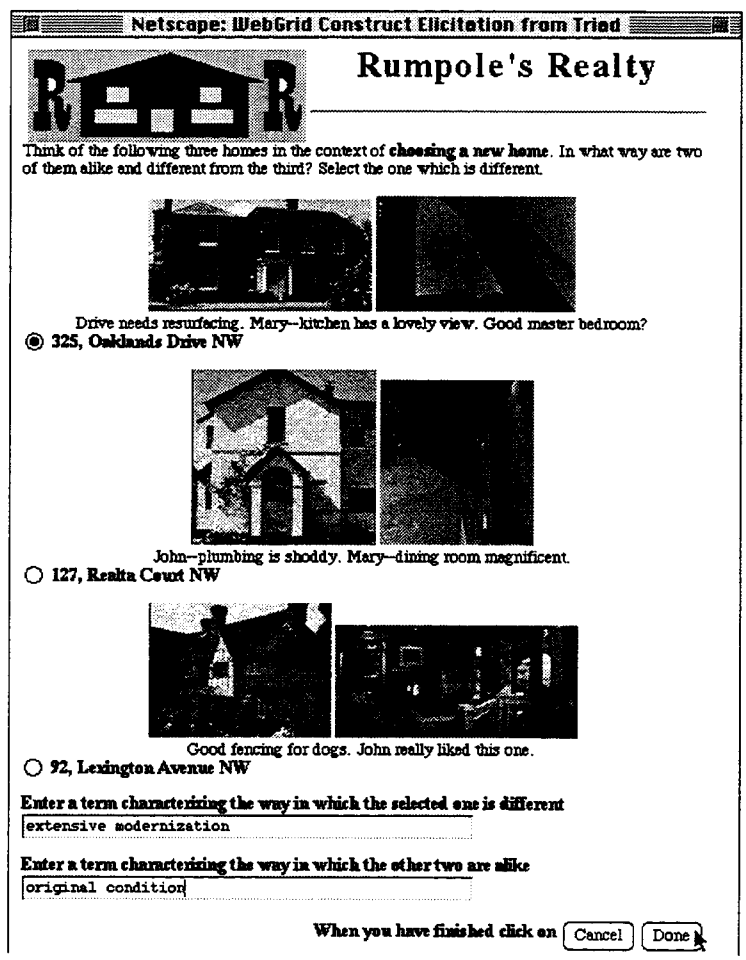

Figure 3 Triadic elicitation of a construct distinguishing elements

When the user clicks on "Done" WebGrid generates the form shown in Figure 4 which uses popup menus to allow all the elements to be distinguished in terms of the construct. It also allows the pole names to be changed or the original elements to be re-rated, if appropriate. WebGrid is designed to be non-modal, and allow users to easily edit previous entries at every stage.

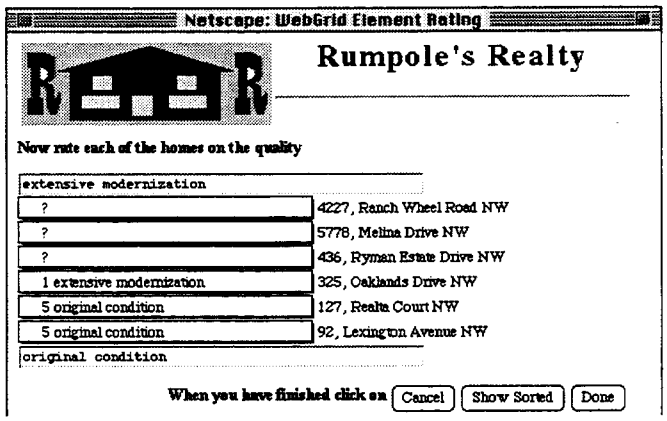

Figure 4 WebGrid form for rating elements on a construct

Figure 5 shows the popup menus being used as rating scales to position the elements along the construct.

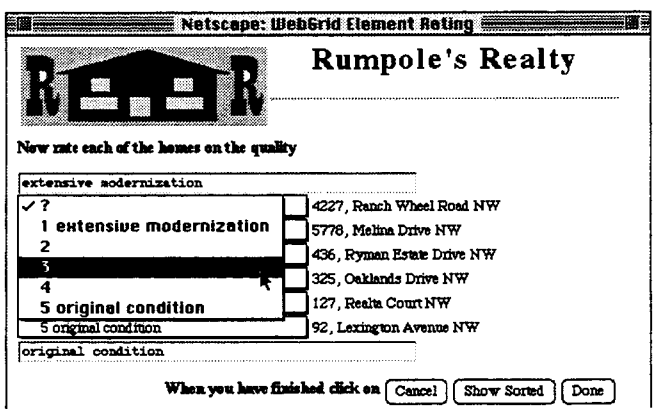

Figure 5 Using popup menus to enter ratings

When all the elements have been rated the user can either click on "Done" to enter the data, or on "Show Sorted" to see the entered data positioned along a scale as shown in Figure 6. This is useful to check whether the order of the elements along the construct makes sense to the user.

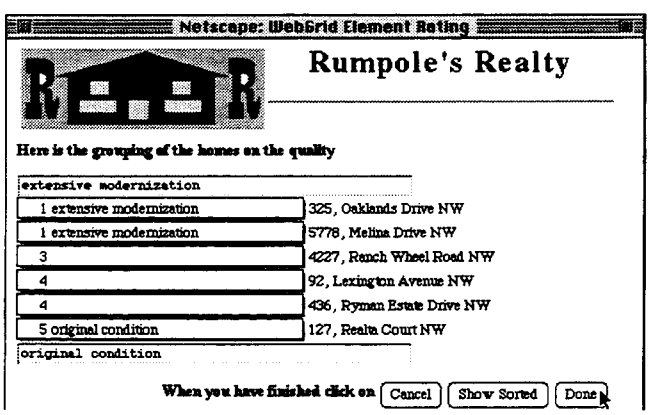

Figure 6 Showing the elements sorted along the construct

2.3 WebGrid Other Elicitation Facilities

When the user finally clicks on "Done" WebGrid generates its main status screen as shown in Figure 7 (after 6 constructs). This is divided into sections suggesting various actions that may be taken. WebGrid continually computes matches between elements and between constructs, and suggests that additional constructs or elements be entered to help reduce similarities which may be due to insufficient data having been entered. It allows the elements and constructs already entered to be edited, and it provides access to various analysis tools which are illustrated later.

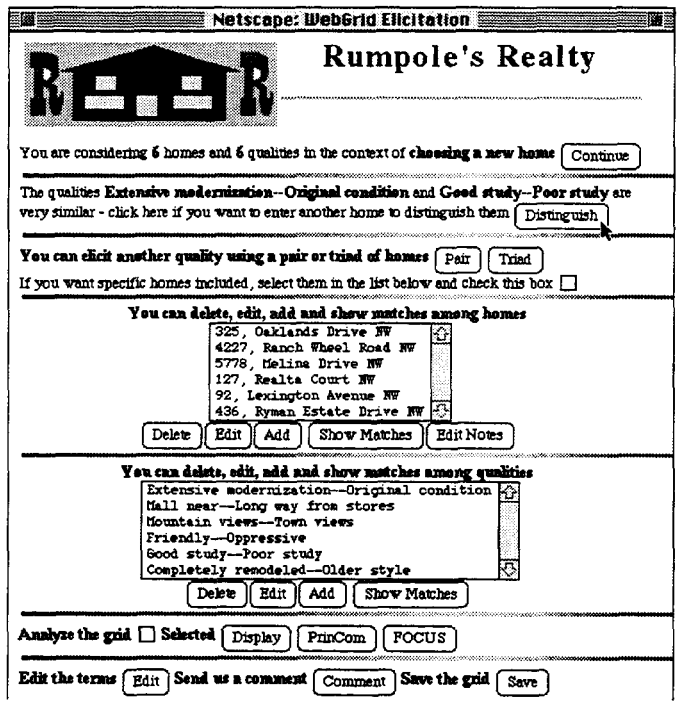

Figure 7 Main status screen of WebGrid after 6 constructs have been entered

The suggestion at the top of the screen is that the constructs "Extensive modernization—Original condition" is closely matched with "Good study—Poor study". This may be a coincidence based on the small set of homes entered, or it may reflect a significant phenomenon such as modernization being improving study facilities. John and Mary decide to investigate this match, click on "Distinguish", and WebGrid generates the screen shown in Figure 8 which poses a very specific question—can they think of a home which is modernized and has a poor studyor in original condition and has a good study.

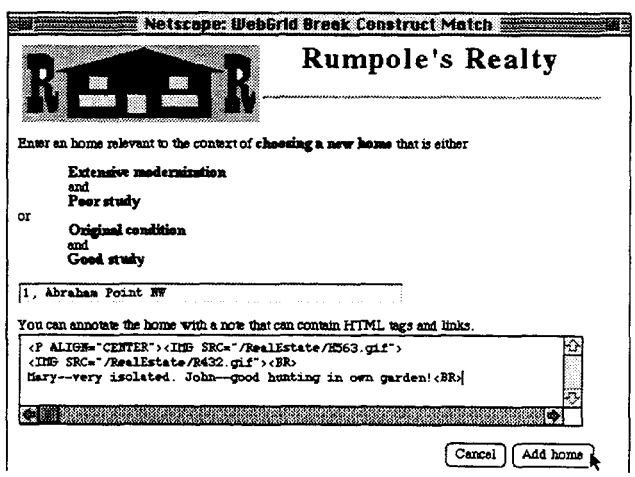

Figure 8 Eliciting a new element to break a construct match

This triggers the realtor into suggesting they view a particular home which she thinks may interest them that is modernized and has a study. They visit the home and add it as a new element as shown in Figure 8. WebGrid then generates the screen of Figure 9 asking them to rate the newly entered element on the existing constructs.

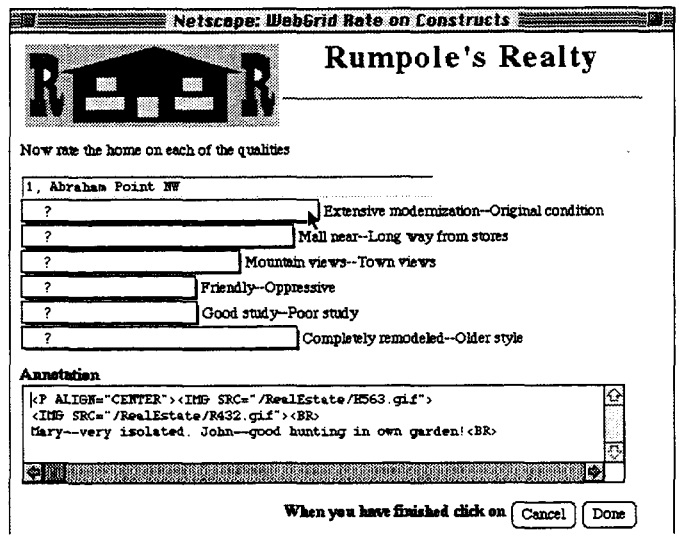

Figure 9 Rating a new element on existing constructs

2.3 WebGrid Modeling Facilities

As a final element, the realtor has John and Mary add the conceptual element, "Ideal home", and rate it on the existing constructs. This defines the preferred value, usually a "preferred pole", on each construct for WebGrid. The users now chose one of the analysis programs, *PrinCom*, to generate a map of the relations between constructs and elements. PrinCom does a principal components analysis of the grid data, attempting to represent it in as few dimensions as possible. WebGrid plots the first two components and returns them as a GIF as shown in Figure 10. It can be seen that there are two major clusters of dimensions characterized by "Friendly—Oppressive" and "Extensive modernization—Original condition". It can also be seen that "Ideal home" clusters most strongly with "1, Abraham Point".

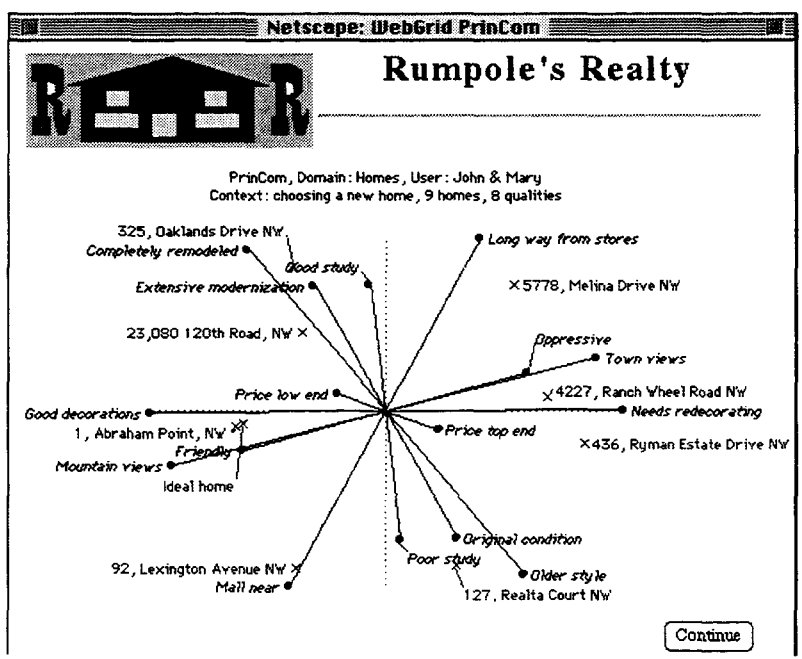

Figure 10 Map produced by PrinCom principal components analysis

The users also use the FOCUS analysis program to sort the grid so that similar elements and similar constructs are clustered together. WebGrid graphs the data and returns it as a GIF as shown in Figure 11. Again, it can be seen that "1, Abraham Point, NW" is closest to being the "Ideal home". Because the original grid data is shown, it is possible to see how this home and the others differ from the ideal.

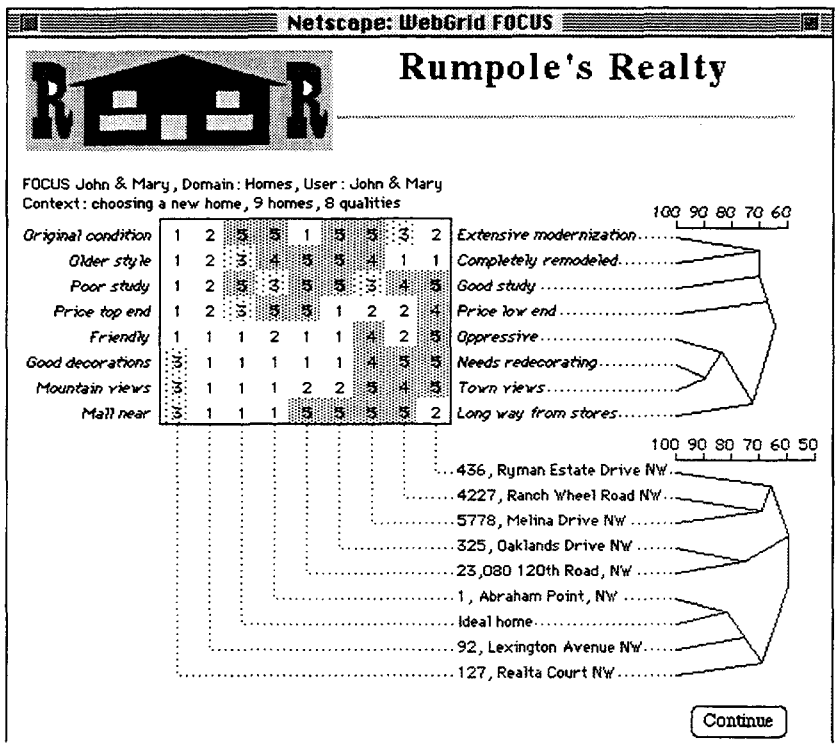

Figure 11 Clusters produced by FOCUS sorting analysis

The sequence of interaction in a real estate application shows how repertory grids may be used interactively across the web to elicit and model personal knowledge. This example is illustrative of a wide range of personal decision making applications, choosing among options, such as a new job or a new car.

3 Conclusions

When we commenced the development of WebGrid, knowing the limitations of HTML forms, we had no great expectations that the resultant tool would be attractive to use. We have spent many years carefully developing user interfaces with good human factors targeted on repertory grid elicitation, and knew the need for special-purpose graphical "widgets" that could not be emulated in HTML. We are enthusiastic users of World Wide Web for publication, and were interested to see what could be achieved with more interactive, collaborative tools, but felt that the technology might not yet be adequate for what we wanted to achieve. We were more than pleasantly surprised by the human factors and attractiveness of WebGrid. The free-form HTML documents with embedded widgets in many ways gave us more flexibility than we had experienced in the design of the original RepGrid interface, and interaction with WebGrid has proved natural to our user communities. From a programming perspective, HTML forms provide a cross-platform graphic user interface that is simple to prototype, easy to customize, and whose simple primitives help to support the basic human factors guidelines of *uniformity* and *consistency* (Gaines and Shaw, 1984).

One objective in the original WebGrid development was to preserve the stateless nature of the HTTP protocol. No data is stored at the server between transactions. In particular, this makes it possible for us to offer WebGrid as an open service on the web without being concerned about managing the storage of other people's data. However, we are also concerned to support collaborative communities as we have done with RepGridNet (Shaw and Gaines, 1991; Shaw and Gaines, 1993), where members can make their grids available to the community. This raises many problems of authorization, protection, and so on. It is not easy to design a system for the web that has open, easy access, yet avoids data loss or unwanted interference through careless or deliberate actions.

The real estate application was chosen to illustrate this article because it provides a good example of how a web-based system can be customized by end users. The web offers excellent facilities for dynamic hypermedia and for integrating these facilities with structured interaction to enhance general client-server programs.

WebGrid provides many additional facilities not illustrated in this paper. It allows a user to commence an elicitation based on another person's grid, either using just the elements in it and developing his or her own constructs, or using both elements and constructs but commencing with all the rating unknown (an "exchange" grid). In the first case the new grid may be compared with the original one to determine what *constructs* correspond in the two grids—the users may be making the same distinctions but giving them different names. In the second case the new grid may be compared with the original one to determine to what extent the *ratings* correspond in the two grids—the users may be making different distinctions but giving them the same names. These facilities are used with students to support collaborative learning (Shaw and Gaines, 1995) and with groups of experts to explore difference in the use of constructs and terminology (Shaw and Gaines, 1989).

WebGrid also provides the expert system development tools based on repertory grids that have been used extensively in knowledge-based system development (Gaines and Shaw, 1993a; Gaines and Shaw, 1993b). One option in Figure 1 is to allow a wider range of data types including categorical data, numbers, dates, and so on, and when this is selected additional choices appear on WebGrid elicitation and analysis screens.

We are using WebGrid routinely to support graduate and undergraduate teaching (Shaw and Gaines, 1996). It is also available on the Internet, and in the period July-December 1995 WebGrid was accessed from 674 different sites in 30 countries. The web is essentially an anonymous medium and we do not track the activities of outside users. However, occasionally users contact us to discuss their applications and, if the local network goes down, we receive mail from serious users reporting the problem and requesting notification of when the knowledge acquisition programs will be available again. An interesting example of serendipitous use was a masters student in Holland studying operators' models of nuclear reactors who came across the grid elicitation system on the web in September, used it with his experts to elicit their conceptual models, and included these in an additional chapter in his thesis for examination in October—the web certainly accelerates research processes.

Acknowledgments

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