COGNITIVE ISSUES IN REPRESENTING DESIGN REASONING AS HYPERTEXT

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Abstract: Hypertext offers powerful facilities for representing and manipulating structure, but the cognitive task of parsing ideas into discrete chunks can be intrusive. This summary describes ongoing work looking at the use of semi-formal notations for representing design reasoning. One experiment highlighted a number of cognitive overheads in using the notation, but a subsequent study is indicating that with training, the notation can be used unobtrusively by computer scientists to record reasoning during design problem solving.

Hypertext has been used as a representational medium for structuring ideas in a number of experimental systems [1], [2], [3]. One of the cognitive requirements for users of such tools is to convert the flow of ideas into a structure by parsing ideas into discrete chunks (nodes) and identifying the relationships between them (links); this is often unnatural for users, and at times can be intrusive to the point of distracting users from the real task in hand [1], [4]. The aim of the present research project is to gain some understanding of the processes involved in the use of structured notations amenable to hypertext support, that is, notations using the constructs of typed objects and relationships.

It is in this context that the domain of design and semi-formal design notations is being studied. Work with notations like IBIS [1] (Figure 1) and Design Rationale [5] (Figures 2 and 3) exemplifies the potential of semi-formal notations for representing design reasoning and rationalisation, and although there is initially encouraging evidence that such notations map both conceptually and pragmatically to real world design activity ([6], [7]), closer experimental work is needed in order to build a clearer understanding of the properties of a notation, the way it affects design discussion, and the role which tool support like hypertext might play. The work described below is designed with these questions in mind.

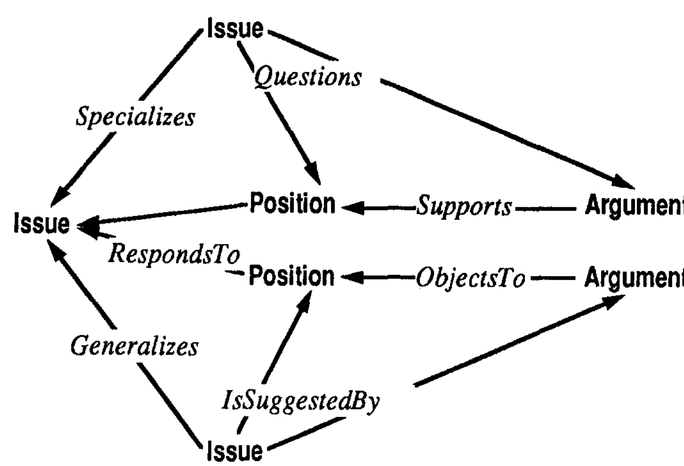

Figure 1 The legal relationships between entities in the IBIS notation, providing a representational framework for design discussion. Implemented as hypertext nodes and links [1], as deliberation proceeds new nodes are added, and so directed graphs 'grow' with the discussion.

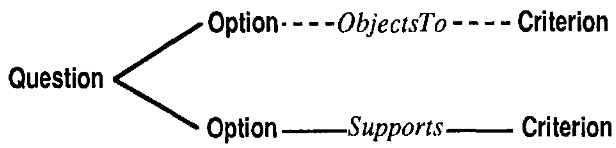

Figure 2 Design Rationale uses Questions, Options and Criteria to express design reasoning, with typed relationships between Criteria and Options. Currently, there is no specialised tool support for the notation, and representation of a design session typically takes the form of a set of Questions and associated argumentation.

In an initial study, seven HCI researchers performed a design task using the Design Rationale notation to record reasoning (using pen and paper). Video and protocol analysis revealed a number of problems in using the notation. Difficulties included: classifying ideas according to the available node types, maintaining a consistent level of detail, preserving consistency over decisions, and revising notation. The notation also aided design by virture of the node types it uses, which prompted further thinking, eg. realising an inconsistency between decisions due to conflicting criteria, or identifying a new issue to be resolved whilst generating options to an existing one. Two hypotheses were considered relating to the problems subjects encountered:

(i) The utility of the notation depends on the extent to which material to be represented is understood and structured. Naming and classifying entities and relationships when ideas are few and undeveloped is difficult as the status of ideas is still unknown, and may force premature decisions; thinking in the structured way which the notation encourages may be better reserved for later evaluation of ideas when the problem is better understood.

(ii) User difficulties are primarily due to lack of familiarity with the notation. Given training, the notation will be shown to be useful across all stages of design reasoning.

These hypotheses are being pursued in an experiment currently under way. Computer science students first undergo training in the use of the notation, and then use it in pairs to represent their reasoning whilst tackling a design problem. The notation uses *Issue, Option* and *Criterion* node types, and *Supports* and *ObjectsTo* link types between Criteria and Options; the experimental task is to redesign a bank's Automated Teller Machine interface, as described in [5]. In order to test the suitability of the notation for different stages of the problem solving process, the design problem is presented in either an unstructured or structured form. In the former, the problem statement is brief, and no detailed cues provided as to the relevant issues or criteria to consider, thus simulating a situation where designers are just beginning to generate ideas over a new problem. In contrast, the structured problem statement proposes an alternative design for consideration, and provides additional information on problems with the existing design, cueing subjects to pertinent issues, design alternatives and relative advantages. This condition represents a situation where there has already been some analysis of the problem or similar classes of problem – the key issues are clearer, and a body of ideas now needs to be organised.

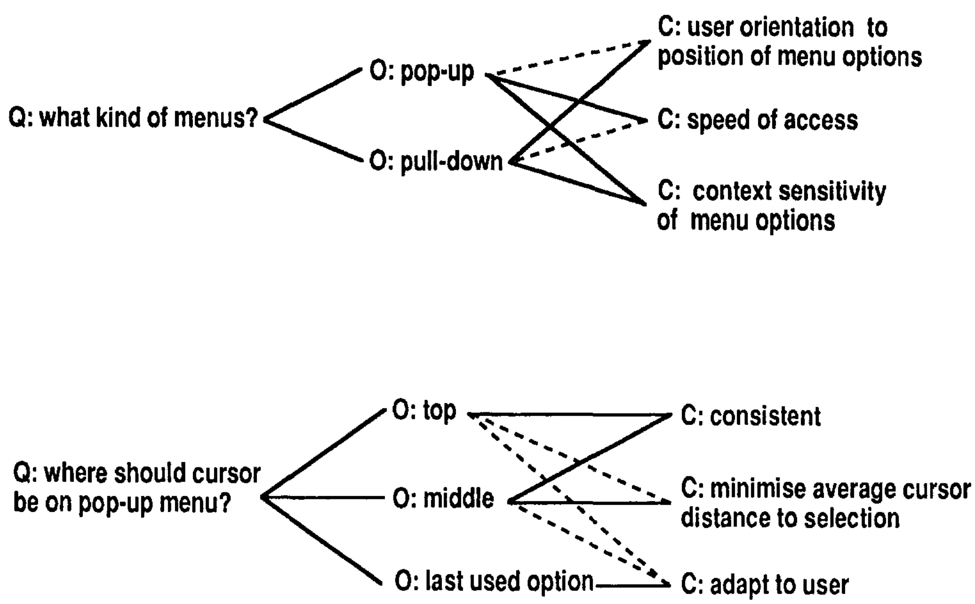

Figure 3 Using Design Rationale to represent reasoning over an interface problem.

Collection and analysis of video, audio, and notational data is in progress; initial results indicate that the training has been successful for eight subjects, who are able to appreciate both the underlying rationale, and potential benefits of the notation to their own work. Furthermore, the notation seems to be used effectively for representing both structured and unstructured design reasoning. It would seem that relatively brief training (2.5 hours in this study) is sufficient for designers to accommodate the structure which the notation imposes on the deliberation process, without it disrupting idea generation and evaluation.

One product of the current work is the 'scripted video' methodology. As part of training in representing the output of design deliberation as notation, subjects are shown video extracts of two actors following a design script. This is being trialed as a means of exposing subjects to excerpts of realistic design activity (in this case dialogue and design sketches), whilst the experimenter maintains complete control. This may also prove an effective way of studying the evolution of the notational representations: subjects represent the reasoning in a video extract as notation, are allowed to revise it after watching it a second time, and then work together to produce a representation which combines the best of each. Studying differences in the use of a notation, and the subsequent revision of structure in the light of contrasting perspectives – for example, views of what the key issues or criteria are – is one way of exposing the notation's strengths and weaknesses.

In summary, the use of semi-formal notations is a potentially powerful way to capture and display the reasoning behind a design which is so often lost, and managing large structures should be substantially aided given hypertext support. Ongoing work demonstrates (i) the effectiveness of certain training techniques in teaching the notation, and (ii) that design problem solving with both structured and relatively unstructured content need not be disrupted through the use of a semi-formal notation. As the current project proceeds, it should be possible to make more specific statements about differences in the notation's use for structured and unstructured problems.

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Simon Shum is a doctoral research student at the University of York, working on cognitive issues in the use of hypertext representations. He has a B.Sc. (Hons.) degree in Psychology from York, and an M.Sc. in Ergonomics from University College London. He participated recently in the Doctoral Consortium at CHI'90. Previous research covers the use of spatial metaphor in hypertext, and cognitive modelling of users.