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# Interfacing the Expert: Characteristics and Requirements for the User Interface in Expert Systems

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**ABSTRACT**

Because expert systems deal with a new set of problems presenting unique interface requirements, special issues requiring special attention are presented to user interface designers. The prime issues addressed in this paper are 1) *External Knowledge Representation:* how knowledge is represented across the user interface, 2) *Modes of User-System Interdependence:* advisory, cooperative, and autonomous, and 3) *Management of Uncertainty:* deciding what actions to take or recommend based on incomplete evidence.

## INTRODUCTION

The user interface is critical to the effectiveness of expert systems. Although its importance in securing user acceptance is well known [3], the issue goes beyond concern for acceptance. The interface affects overall system performance. This is because an expert system's ability to solve real problems depends on the accuracy, not only of its knowledge base, but of the factual context established during interaction.

Because many expert system development efforts are begun as feasibility studies, the user interface is often neglected [5]. But if the system is to be integrated into the workplace, the interface is essential to its success. And to construct a finished product, a significant portion of the development effort must go into the interface. Bobrow, Mittal, and Stefik [2] indicate it is not unusual for the interface to account for one-third to one-half of the code comprising an expert system.

Advanced technology in support of the user interface is plentiful. 'High bandwidth' techniques such as windows, icons, and direct manipulation have come to typify the state of the art user interface. Bringing these techniques to bear on particular applications, however, is not easy [1]. Advanced interface techniques are no guarantee of a usable system.

Use of techniques must be guided by higher level concepts, such as intuitiveness, credibility, and locus of interaction control. Techniques focus on the interface mechanisms; concepts provide the criteria for selecting and melding them into a coherent, usable system. This paper attempts to identify a set of

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general characteristics of expert system use interfaces which set them apart from the interfaces of conventional applications.

That intelligent systems in general differ functionally from conventional systems may be seen as a continuation of a trend. It has been observed that the tendency towards increased automation within society has caused a shift in the human's role from operator tasks involving perceptual and motor activities to cognitive tasks emphasizing monitoring and evaluation activities [4]. As systems become more intelligent, this trend is taken a step further. Expert systems undertake to perform cognitive activities previously reserved for humans, and they do so in domains previously beyond the purview of automation. This causes the burden of decision making responsibility to shift from the user to the system. That people would look to machines for the kind of support offered by expert systems is in itself a change in both the user's role and the system's role.

## EXPERT SYSTEMS AND THE USER INTERFACE

Several aspects of expert systems are significant in levying unique requirements on the user interface, including external knowledge representation, modes of user-system interdependence, and management of uncertainty. These characteristics and their corresponding user interface concepts are summarized in Figure 1 and are discussed in detail below.

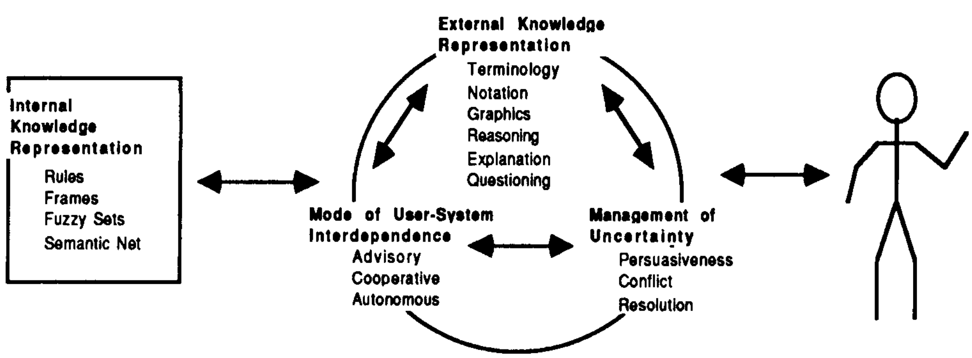


Figure 1: Characteristics of Expert System User Interface

### External Knowledge Representation

In designing an expert system, it is helpful to distinguish internal and external representation of knowledge. Internal knowledge representation pertains to how facts, theories, and beliefs are mapped for the purpose of internal manipulation (e.g., frames, objects, rules, and fuzzy sets). External representation refers to how knowledge is represented across the user interface. It is the terminology, rhetoric, notations, depictions, and styles of interaction associated with the problem domain.

External knowledge representation is important in making the expert system intuitive and credible. Intuitive software minimizes the learning required to use the system by building on the user's previous knowledge and expectations [8]. Because interaction with an expert system tends to be a knowledge intensive activity, using the system demands more than familiarity with basic operations such as keyboard commands, menu selections, function keys, etc. For an expert system to be intuitive, it must exploit the user's expectations as to how ideas are organized and expressed within the system's problem domain.

External knowledge representation can be used to support intuitiveness and credibility in several ways: 1) terminology, notation, and graphics should be modeled on the target domain; 2) reasoning should be represented in human terms rather than machine terms; 3) explanations should be explanatory, rather than a traceback of activated rules; 4) questioning should be progressive rather than arbitrary. Also, because interaction errors may be cognitive misunderstandings rather than syntactical typos, they may not be readily detectable, and the user, rather than the system, may be better positioned to notice them. The system may support recovery from such errors by permitting the user to alter the findings of the system by subtly changing the context.

**Mode of User-System Interdependence**

The mode of user-system interdependence influences the amount and complexity of information exchanged between the user and the system. It also determines the locus of decision-making responsibility, and along with this, the locus of interaction control. There are three modes of interdependency: advisory, cooperative, and autonomous:

1) Advisory expert systems interact with a user who has no expertise in the system domain. While these systems may employ a high level of experise internally, their interactions must be gauged to the user's level. This may require the system to resort to incomplete analogies, over-simplifications, and loosely defined terminology. The system has prime responsibility for gathering information needed for reliable results.

2) Cooperative expert systems support experts in solving problems in their area of expertise [6]. The system may be subordinate to the user, so that the user is in control of interaction as well as decision making [7].

3) Autonomous expert systems are capable of selecting and executing processes without user intervention. The user functions not as a source of facts to be added to the context, but instead as an evaluator, monitor, and manager [4].

## Uncertainty Management

Some research indicates that use of numerical probabilities in expressing uncertainty is ineffective because users (as well as experts and knowledge engineers) do not easily understand them [5]. But the problem goes beyond this. Uncertainty must be managed in terms of how persuasive the system is in presenting its conclusions. From the user interface perspective, the issue is not so much one of determining what conclusions can be inferred from the factual context, but of determining what advice to give or what actions to take on the basis of conclusions reached. Consider the following:

1) There is a 75% chance of rain today
2) It will probably rain today
3) Take an umbrella!

These statements could come from a hypothetical weather expert. The first two statements accomplish essentially the same thing: they leave it up to the user to decide how seriously to take the threat of rain. They simply address the question of whether it will rain today; they do not, unlike the third statement, presume to tell the user what to do. This may be acceptable as long as the issue is one of relatively trivial importance. Suppose the example instead involved a life-threatening disease but the probability were only 10% instead of 75%. The odds are much lower, but the stakes much higher. It might be unsatisfactory to simply tell the user the odds in this case. The interface must tread the narrow line between compelling the user to action and causing undue alarm.

Another aspect of uncertainty management is conflict resolution. Depending on the mode of user-system interdependency, presenting multiple conflicting conclusions for user consideration may or may not be acceptable. With cooperative systems, the user accepts final responsibility for resolving conflict. With advisory systems, however, the user may be unequipped to choose among conflicting alternatives. Advisory expert systems that provide users with a list of possibilities in lieu of definitive results may succeed in reducing the developer's liability, but the effectiveness of the system is compromised.

## CONCLUSION

The ability of an expert system to solve real problems depends significantly on the accuracy, not only of the knowledge base, but of the factual context as well. The context cannot be established accurately if the user fails to consult the system as intended, or if the system fails to support the user in conveying the appropriate information. For expert systems to provide this support, careful attention to the external knowledge domain, the mode of user-system interdependency, and the management of uncertainty is required.

Because of the importance of the user interface, designing effective expert systems requires developers to do more than simply deal with the knowledge comprising the problem domain. For effective external knowledge representation, it is necessary to consider the way experts and users view the domain, and to accomodate these perspectives in the user interface. Selecting the proper mode of user-system interdependence requires that the developer examine the demands the system makes of the user, the demands the user makes of the system, and how these demands may be met. With respect to uncertainty management, it is necessary to fully grasp the implications of any conclusions reached in terms of their intended effect on the user.

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