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An Interaction Initiative Model for Documentation

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An Interaction Initiative Model for Documentation

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ABSTRACT
In this paper we propose a model of creation and use of documentation based on the concept of mixed-initiative interaction. In our model, successful single-initiative interaction is characterized by grounding of contributions, and successful mixed-initiative interaction is characterized by both grounding and agreement. Just as in spoken conversation, achievement of actual agreement depends on the intentions of both parties; agreement is achieved when the reader follows the documentation's instructions. In fact, readers are not obligated to—and often do not—act according to the author's intentions. By making these dynamics explicit, the model can aid authors in developing effective documentation. The paper describes the model and its antecedents, explains the application of the model to documentation, discusses implications such as effects of printed versus electronic forms of documentation, and outlines future work that includes empirical testing of the model.

Categories and Subject Descriptors
H.5.2 [**Information Interfaces and Presentation**]: User Interfaces – *Training, help, and documentation, theory and methods*

General Terms
Documentation, Design, Human Factors

Keywords
Initiative, mixed initiative, grounding, agreement

1. INTRODUCTION
While the give-and-take of live, personal interaction might be a more effective means of providing help, authors normally must produce documentation long before the user reads it. As a result, designers of documentation may discount the contributions the user makes in navigating, understanding and applying documentation.

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Perhaps documentation could be more effective if it could be produced from a model where both author and user jointly contribute to the success of the user's task. Certainly in hypertext documentation, and even in print documentation, there may be ways to model and take advantage of users' contributions to solving their problems. This paper proposes such a model, based on the notions of initiative and mixed initiative. In particular, we develop a model of initiative that enables rethinking the assumption of single initiative in the author.

The paper describes the model and its antecedents, explains the application of the model to documentation, discusses implications such as effects of printed versus electronic forms of documentation, and outlines future work that includes empirical testing of the model.

2. RELATED WORK
Researchers have applied interaction models such as speech-act theory to documentation. Tazi and his colleagues have developed models that, for example, distinguish domain acts (actions involved in accomplishing a task) from meta-acts (actions involved in controlling the interaction) [13, 12]. These models have a well-articulated approach to expression of what amounts to virtual speech acts in written form, where the way the acts are expressed is related to their intended effects. The meta acts explored by Tazi and his colleagues related the form of an expression to the act embodied in the expression. In other words, what an element of the documentation is intended to accomplish is enhanced by cues provided by its form of expression, and these expression-based cues constitute kinds of acts in themselves. For example, domain acts for an aircraft operating manual might include "choose mode" and "warn," while meta-acts used in expressing the domain acts might include "direct attention" and "indicate affordance."

Speech-act models of interaction based on planning were famously criticized by Suchman [11], who argued that a more spontaneous approach, which she termed situated action, leads to better interaction. Documentation likely would be considered the epitome of planned interaction, as the totality of the author's contributions is produced before the reader begins to interact with them. In documentation, which by its nature has to be authored before use, the documentation's interactive acts necessarily have to be planned. So the challenge for developers of documentation and help systems is to find ways in which the user's interaction with documentation could be provided with the feeling of the give-and-take of situated action.

The point of Suchman's contribution was twofold. First, to the extent that the system understands the user's actions as situated, the meaning of the user's actions can be disambiguated. Second, the system's understanding of the user's actions provides the user with a context in which he or she can follow cues to further action that make sense. The user may not know the entire sequence of actions needed to reach some goal but the local signposts after each action are sufficient to show the next step in the right direction. One might say that situated action gives the user the sense that they are leading the interaction in the direction they want; the system's communications seem naturally helpful and unobtrusive. Although Suchman did not characterize her model in this way, the system also stands ready to guide when the user seems to be getting off track. This quality of both the user and the system guiding the interaction can be characterized in an intuitive sense as *mixed-initiative* interaction.

Speech-act models of documentation addressed Suchman's objections by remaining agnostic about whether the user's interaction with the documentation—in print or on-line—was planned or situated, even if the entirety of the author's contribution to the interaction had to be written in advance of its use. As a natural reflection of the perception that it is the author who controls the creation of the text, discourse initiative in documentation is effectively assumed to be assigned to the author. All interaction in documentation is thus considered single-initiative rather than mixed-initiative. Consequently, researchers in the area of speech-act models for documentation have not directly addressed the question of initiative. The set of meta-acts articulated by Tazi and his co-authors focused on the means by which domain acts are expressed rather than the allocation of acts between user and documentation. In this approach the author posits a model of the user interacting with the documentation, with the control of interaction necessarily in the purview of the user. The underlying concept, though, is one in which the author sets out what the user should do. For example, documentation that specifies procedures is prescriptive in that the user is supposed to follow a prescribed plan of action [13]. But users are not bound to follow the prescription and often—even in safety-critical contexts—modify or abandon prescribed procedures [5]. One could thus argue that documentation, far from being a single-initiative interaction controlled by the author, is instead a single-initiative interaction controlled by the user.

Even if the concept of initiative at best has been modeled in documentation in terms of implicit assumptions, initiative has been addressed explicitly and in depth for spoken-language dialogue systems [7]. Notable models of interaction initiative for spoken language include those proposed by Walker and Whittaker [15], Chu-Carroll and Brown [2], and Cesta and D'Aloisi [1]. These models, however, tend to rely on intuition-based definitions of initiative. These intuitive concepts include factors such as who is leading the conversation or who is "able to decide the next step." Such models are not particularly amenable to objective verification, though, because initiative remains a high-level judgment of the observer; they are definitional rather than analytical. The goal of this paper, then, is to propose a model of initiative that (a) is better suited for empirical validation and (b) can be useful for creators of documentation. The next section explores our initiative model and the following section explores its application to documentation.

3. AN ANALYTICAL INITIATIVE MODEL

Previous initiative models, based on concepts such as taking the lead or moving the interaction forward, are defined in terms that are largely synonyms for the intuitive concept of initiative rather than analytical models that comprise a set of supporting factors. We propose, in contrast, a model based on specific components of the interaction, namely grounding and agreement. Like the models developed by Tazi and his colleagues, our model of initiative in documentation relates the effectiveness of an interaction to the conditions in which it takes place. These conditions include the participants' intentions, their understanding of the interaction, and what they jointly accomplish. The initiative model both draws inspiration from Tazi with respect to the relationship between author and user and extends the meta-act model to include acts relating to initiative and turn-taking.

In our model, successful single-initiative interaction is characterized by grounding of contributions, and successful mixed-initiative interaction is characterized by both grounding and agreement. To ground a contribution to the interaction is to establish it a mutually understood by the participants at a level of certainty sufficient for their current purposes [3]. In particular, we hypothesize that single and mixed initiative interaction can be distinguished in terms of the accepting acts required by the interaction:

- **Single-initiative** interaction is one in which the propositional content of a contribution requires grounding but not agreement to become part of the mutually-held beliefs of the conversants.
- **Mixed-initiative** interaction requires both grounding and agreement before the content of the contribution is assumed to be mutually believed.

Even though it is built on component discourse factors, validation of the model still poses difficulties. We have had some success in applying conversation-analytic techniques to examples used by other researchers in discussing mixed initiative interaction. Tables 1 and 2 show representative analyses for two samples discussed by Chu-Carroll & Brown [2]. The columns of the tables indicate: whether or not the utterance requires grounding (Grd: +g or –g); whether or not the utterance requires acceptance (Acc: +a or –a); the speaker (usually "User" and "System"), the utterance, and our heuristic for determining whether or not acceptance is required.

Grounding is relatively easy to determine. Researchers have been able to analyze grounding acts readily (see, e.g, [14]). In fact, it is highly unusual to find an utterance that does not require grounding. This is evident in the two examples, where every utterance is classified as +g. The situation is not as simple for acceptance, though. While many of the examples from Chu-Carroll and Brown can be classified with respect to acceptance, the utterances in other of the examples remain difficult to classify, largely because they often lack context sufficient to distinguish among possible alternate interpretations. Even with these difficulties, though, we have been able to work through many examples and, in doing so, identify recurrent heuristics for classifying utterances as requiring acceptance or not, and thus classifying utterances as mixed-initiative or not. While a complete list of heuristics, particularly for utterances not requiring agreement, is beyond the scope of this paper, here are examples of heuristics that we have developed:

Requires agreement

- Asking for agreement
- Proposing a joint action or plan

Does not require agreement:

- Stating the speaker's past action
- Stating intention
- Stating something about which the speaker has sole knowledge
- Asking about someone else's intention

Gnd	Acc	Spk	Utterance	Heuristic
+g	-a	U	I'm looking for Saudi Arabian Airlines on the night of the eleventh.	questions asking for information do not require agreement
+g	-a	S	Right, it's sold out	answers to questions for which the responder has the knowledge cannot be subject to agreement
+g	-a	U	Is Friday open?	questions asking for information do not require agreement
+g	-a	S	Let me check here. I'm showing economy on Pan Am is open on the eleventh.	answers to questions for which the responder has the knowledge cannot be subject to agreement

Table 1. Conversation analysis of single-initiative interaction

Gnd	Acc	Spk	Utterance	Heuristic
+g	+a	U	Yeah, so go to Bath and pick up the boxcar, bring it back to Corning and then bring it back to Elmira.	suggestion for joint action requires agreement
+g	+a	S	Okay, well that's 8 hours, so you're not gaining anything by doing that.	suggestion for joint action requires agreement
+g	-a	U	Okay [2sec] [sigh] Any suggestions?	questions asking for information do not require agreement
+g	+a	S	Well, there's a boxcar at Dansville and you can use that.	suggestion for joint action requires agreement

Table 2. Conversation analysis of mixed-initiative interaction

4. INITIATIVE IN DOCUMENTATION

In discussing the complementary processes of writing and reading documentation, Tazi and his colleagues [12, 13] pointed out that the use of meta-acts, like expressing something in a particular style, is a kind of author's commentary on the domain acts about which he or she is writing. The underlying content of the documentation comprises the body of the text, and the meta-act commentary aids the user in perceiving the author's intentions with respect to the user's understanding and use of the text. Implicit in the description of the writing process in terms of meta-acts is an author's cognitive model of the reader. Using this model, the author designs the documentation so that it produces what the author understands to be the user's likely interpretation of and reaction to the documentation [8]. Tazi et al. have likened this modeling to a kind of pre-interpretation of a dialogue between documentation and user. In other words, the author imagines, based on his or her model of the user, the user's dialogue act in response to an element of the documentation and then creates the next element of the document in a way that takes the user's imagined act into account. A set of meta-acts has been proposed for documentation [9]. But both the set of meta-acts and the model of a pre-interpreted dialogue related form to content; neither touched upon initiative, that is, who has responsibility in the interaction for grounding and agreement. In this section, then, we explore the implications of considering initiative in documentation, both printed and interactive.

Normally one thinks that all initiative belongs to the author but analysis of initiative in terms of grounding and agreement leads to the conclusion that initiative is shared—or rather, divided. In our model, only grounding is required for effective single-initiative interaction. So in printed documentation if the author's contributions are grounded by the reader we can, at best, attain single-initiative interaction. We cannot attain real mixed-initiative interaction in static documentation because the parties cannot reach genuine agreement. However, if the user acts in a way that reflects what would have been agreement, then we might be able to consider the interaction to have a kind of mixed initiative. Even though printed documents cannot actually form a joint intention with the user, they may "pre-agree" with the user with respect to a proposed action. In the case of on-line documentation, a manual may have a more realistic capacity to agree because the manual can (1) observe the user's actions and progress through the task and (2) dynamically modify its goal structures.

Paradoxically, the author's total control in writing the documentation is trumped by the user's total control in reading and using the documentation, particularly for printed rather than on-line documentation. The difference between printed and on-line documentation arises because writing and reading constitute an asynchronous interaction while normal spoken conversation or on-line computer interaction is synchronous. The notion of initiative in asynchronous interaction differs significantly from that in synchronous interaction. For asynchronous, written documentation, the author does have complete control of the presentation at writing time—but not at reading time, when the reader must exercise all the functions of the interaction. For example, the author may intend and assume that the reader will read the parts of the document in the order in which they are presented, while readers are unconstrained and may read the parts of a document in any order. Indeed, a recent article discussed evidence that expert and novice readers differ with respect to the

order in which they read elements of a document [16]. In this light, hypermedia documents, which provide users the power to customize their exploration of a document, constitute both a power tool for expert readers and a helping hand toward expertise for novice readers.

4.1 Grounding and Single Initiative

Documentation includes both descriptive and procedural elements. The descriptive part requires only grounding rather than both grounding and agreement. That is, the author wants the user to understand rather than to take action; there is no expectation of agreement to act. Thus descriptive text is necessarily single-initiative. This is consistent with our intuitive notion of single initiative: If the manual is the expert, the user is not expected to contribute information back.

In the context of documentation, grounding can be seen as understanding of the document's content by the reader. In spoken interaction, the speaker adjusts the presentation based on feedback from the conversational partner about levels of understanding. In written interaction, the author must "pre-adjust" the presentation based on a mental model of the reader's comprehension.

The fact that the user has control over the reading of the documentation raises the issue of whether there is even effective single-initiative in typical situations. For example, readers are not compelled to read all the material preceding the section that they currently believe to be of interest. As a result, they may not have understanding of terms and concepts necessary for the comprehension of the material they are reading. Studies have shown that users tend first to ignore the documentation, then jump into it when having problems in the middle of a task [9]. This suggests that documentation should be proactive in linking back to supporting terms and concepts, particularly where they may have meanings that diverge from ordinary usage.

The need to connect material to supporting material is a clear rationale for hypermedia, especially for cases like linking back to definitions. One problem with this approach, though, is that offering a link from a term to its definition does not mean that the user will actually follow the link. In cases where a term appears to have an intuitive meaning, users likely will not check to see if their assumption is correct. Another problem is that the link does not say what it goes to, it just says that there's a connection to something else related. This suggests that users would be well-served by providing information on the links that indicates the speech act that the link instantiates. This could be done, for example, via roll-over tags, conventions of style, or even speech. In the case of an implementation involving roll-over tags, when the cursor hovers over a hyperlink, the link could generate a pop-up menu that enables the user to choose from a set of possible acts. In this case, the selection of the particular link could be seen as constituting grounding plus agreement.

For example, Figure 1 shows a text fragment with a hyperlink for the term "speech-act theory." The user knows that this is a hyperlink because it is rendered as underlined and in a different color. But the user does not know what the effect of selecting the link will be. The link might take the user to a definition of speech act, a more detailed explanation of speech acts, or perhaps a history of speech-act theory. Our solution is to make the meaning of the documentation's links available to the user via a pop-up menu of these choices. Figure 2 shows the same fragment with the pop-up menu of links displayed once the cursor has hovered over the "speech-act theory" hyperlink. A prototype implementation has been developed following the method proposed by Hall [6] for menus.

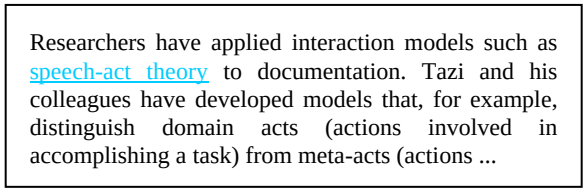

Figure 1. Text indicates hyperlink but does not indicate the meaning of the act of selecting the link.

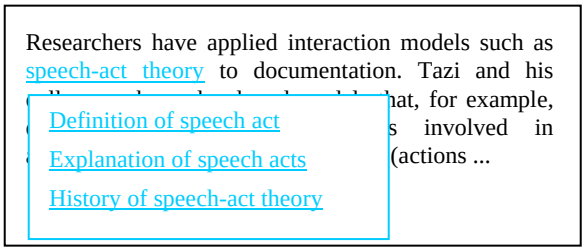

Figure 2. Pop-up menu for hyperlink indicates possible destinations.

More prosaically, this pop-up approach could make documentation more readable by hiding choices unrelated to content, such as choice of format. Figure 3 shows a hypothetical fragment of text with the usual in-line links to different formats for a report. Figure 4 shows the same text fragment with a pop-up menu of links to the format choices.

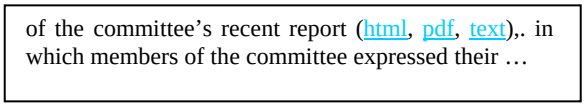

Figure 3. In-line links to format choices.

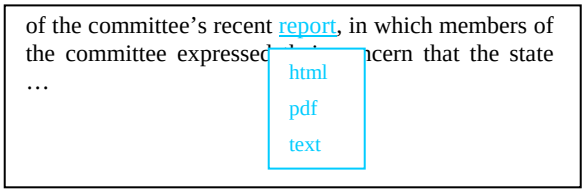

Figure 4. Pop-up links to format choices.

Grounding also affects the pace of use of documenation. Speakers in monologue tend to overproduce because they want to make

sure the hearer doesn't miss anything. Writers of documentation are in a similar situation, so they may tend to write to too low a level for many users. Accordingly, authors' use of techniques such as parentheticals, sidebars and pointers to additional information enables the reader to go at their rate. There are also techniques for enabling the user to speed the interaction, such as providing explicit higher-level structures. In a sense, these kinds of techniques are a substitute for the speed-up and slow-down facilitated by the grounding mechanisms that underlie single-initiative interaction.

4.2 Agreement and Mixed Initiative

In contrast to the descriptive elements of documentation, the procedural elements seek to produce action on the part of the user. This means that the user must form an intention to act, and thus in effect agree with the manual's proposed course of action. So procedural parts of manuals are necessarily mixed-initiative. Agreement in spoken conversation is a jointly created intention between conversational partners [4]. To attain author-user agreement in documentation—in a way that complements the author's "pre-adjustment" of the presentation to attain grounding—the author must "pre-intend" that the reader form an intention to act in a way appropriate to the task context to which the documentation applies. Just as in spoken conversation, achievement of actual agreement depends on the intentions of both parties; agreement is achieved when the reader acts accordingly. Of course, for author and reader to agree on a goal, the documentation must, at the very least, present the goal, and do so at an appropriate level of detail

The reader's ability to agree, though, implies the ability to disagree. One of the reasons that people can find interface wizards annoying is that they often do not provide means for the user to disagree. The user can either proceed or quit, but that's it. Consequently, such interfaces feel archetypally single-initiative. In mixed-initiative interaction, readers are not obligated to—and often do not—act according to the author's intentions.. For example, disagreement means, in effect, that the user abandons part or all of the procedure. Empirical studies indicate that airline crews routinely abandon procedures. This is more or less accepted by the airlines because it represents the exercise of professional judgment as to, for example, prioritization of actions or diagnosis of underlying causes [5]. This suggests that a good practice would be to provide users with a sufficient grounding on rationale so that they can form an informed judgment on whether to initiate or continue a procedure. Similarly, the reader the reader is free to read (and execute!) the steps of a procedure in some other order than that intended by the author and presented in the documentation. An author could promote agreement-through-action by explaining the rationale for the order of the procedure's steps.

Prescriptive documentation is analogous to joint-planning dialogues: the documentation's author is presenting a plan for the user's action. Absent coincidence, both the author and the user have to agree on the plan if the user is going to follow a plan indicated in the documentation. In planning dialogues, the parties have to agree on the goal, the steps of the plan, and assignment of duties. In printed documentation, it appears that none of the duties can be undertaken by the documentation; in on-line documentation both the user and the documentation (read system) may have duties.

Some documentation fails to distinguish adequately between descriptive and prescriptive elements. This leads to confusion for users because they cannot easily determine what they are being asked to agree to. Because agreement requires prior grounding, the initiative model strongly suggests that necessary descriptive material precede the corresponding procedural material. This may be a reason why people find tax forms frustrating. Being told to take a series of actions, such as producing a series of calculations, may be confusing if the person does not know the purpose of the series of calculations. How are they to know, for example, if the answer they get is a reasonable one?

A more subtle way in which failure of grounding can lead to failure of agreement is that agreement between author and user may be nominal rather than real. The documentation may provide definitions—even through roll-over hyperlinks—but even if the user knows that there is a definition available for a term they still may not read it. The user may believe that they already know the documentation's meaning for a term and hence may not know that their understanding of the term differs from that of the documentation. These kinds of misunderstandings typically are detected and repaired in synchronous interaction when one of the parties has difficulty understanding a subsequent contribution. In asynchronous interaction, though, there are half as many opportunities to detect misunderstandings because the documentation cannot observe (and thus reason) about the user's actions, and the effect of a misunderstanding may be manifested much later on in the interaction, thus making hard for a user to detect why something has gone awry.

To help the user avoid problems with grounding, the documentation ought to assist the user in establishing a mutual understanding of the user's context in the documentation. That is, when the user dives into the middle of the documentation because it is now, he or she thinks, relevant to solving their immediate problem, the user's understanding of their context is possibly—even likely—incomplete. This suggests that documentation be written in a way that exposes misunderstandings and leads the user to notice and repair them. One way to do this would be to provide occasional check-actions to be performed by the user as they use the documentation. The idea is to achieve agreement-by-action with respect to, for example, meanings of terms. Figure 5 presents a fragment of a manual in which the user is provided opportunities to checkpoint their understanding of the material.

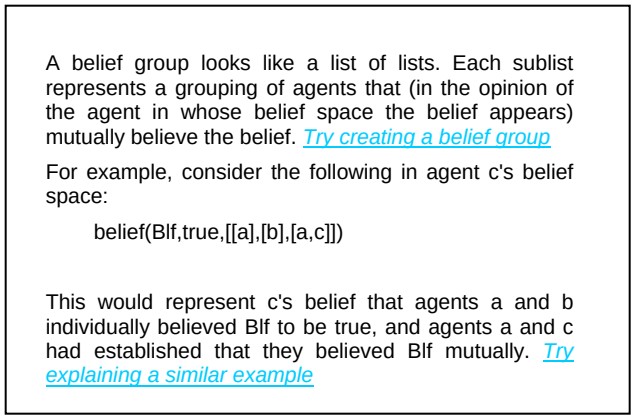

Figure 5. Example of check-points for agreement-by-action

This kind of check-point enables users to verify their understanding, especially for descriptive documentation. A second kind of check condition can be implemented for prescriptive documentation where the user is performing actions, even if the system does not have the ability to observe the user's actions. In human joint-planning and execution tasks, we have checkpoints where the conversants make sure that the task is on track. If it is not, we have ways of diagnosing, backtracking and repairing.. Documentation could have analagous processes by providing users with the means to check the correctness of their own actions. To do this, documentation could (a) supply check conditions that describe how to verify that the effect of a user's action was what was intended and (b) provide ways of backtracking or repairing. An example of this in existing printed documentation is where the instructions for installing a guard on a PDA asked to the user to check its appearance and, if appropriate, realize that the guard had been installed backwards and should be removed and reversed.

Documentation also can aid users in building an understanding of their context by presenting a key to or model of the information that the current section assumes. These include assumptions of both task and knowledge. That is, the section probably assumes that the user is trying to accomplish a particular task and has some level of prior knowledge. This aid to building context could be as simple as textual pointers to prior material. More sophisticated documentation, especially on-line, could provide links to supplemental materials and tutorials.

5. CONCLUSION

In this paper we have presented a model of initiative in interaction that distinguishes single-initiative interaction and mixed-initiative interaction through the presence of or absence of requirements that the content of the documentation be grounded and agreed to. We presented preliminary evidence that this model can be applied to examples of dialogue that supported previous models. The proposed model has advantages for producers of documentation because it is based on verifiable component factors rather than high-level, intuitive terms. We explored the model's implications for both descriptive and procedural elements in documentation. Examples of techniques suggested by the model include roll-over pop-up menus to ground users' understanding of hyperlinks and check-points in procedures to help users attain agreement-by-action.

While our analysis has enabled us to suggest these specific techniques, significant questions about the model and its application remain open. The most fundamental issue involves our claim that the model's factors of requiring grounding and agreement are more objectively verifiable than the formulations of earlier models. While it is true that we were able to determine these factors for many of the dialogue fragments presented by, for example, Chu-Carroll and Brown [2], we had great difficulty in reliably categorizing the utterances of some of the dialogue fragments. We believe that these difficulties are traceable to a lack of context for the dialogue fragments as presented. Nevertheless, authoritative validation of the model will depend on being able to categorize parts of dialogues consistently and completely.

The issues of validation of the model can be addressed through relatively straightforward conversation-analysis studies of dialogues, with multiple coders using a standard coding manual. It would be useful for such a study, though, to have corpora of dialogues more directly related to documentation, such as help-desk dialogues.

A second significant issue involves the utility of the design techniques we suggested. It remains to be determined if these techniques actually improve the effectiveness of documentation for users. Moreover, could improvements in effectiveness from the techniques be linked back empirically to their respective rationales of making grounding more certain and giving documentation the benefits of mixed-initiative interaction?

This issue is also relatively easy to address. Usability studies of prototype documentation, both printed and on-line, could indicate whether the presence of, say, roll-over hyperlink menus actually improves user performance and satisfaction relative to similar documentation without the new features.

A third issue involves the model's own usefulness. Beyond the techniques presented in this paper, what other implications does our initiative model have for documentation? Can we someday arrive at the point where users experience a degree of comfort in interacting with documentation comparable to that in interacting with people?

This sort of issue is much harder to address, as it requires both a deeper insight into the model and a significant degree of design inspiration. As it is now, the model has led to some techniques that may prove useful but it is not in a state where its general application by producers of documentation is obvious. Authors would be better served by a version of the model that has clear and direct application to everyday documentation. We hope to continue our research along a path that leads to this result.

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