Overview

SCI-WISE is an integrated environment that structures and facilitates scientific inquiry through the use of artifacts (e.g., the Research Notebook), advisors (e.g., Helena the Hypothesizer), and the advice they offer (e.g., "Two hypotheses are better than one.") The user enters their work into the artifact, including self-evaluative information. The advisors monitor the contents of the artifact and use this information to determine what advice might be most useful at any given moment.

The system is being developed in Java and is hosted within an internet browser in order to reduce its reliance on any particular platform, operating system, or custom software application. The browser window is divided among the current artifact, advice, and active advisors such that all are visible to the user simultaneously (i.e., the panes devoted to these entities do not overlap.) This allows the user to clearly understand the relationship between the advice being given and their own work.
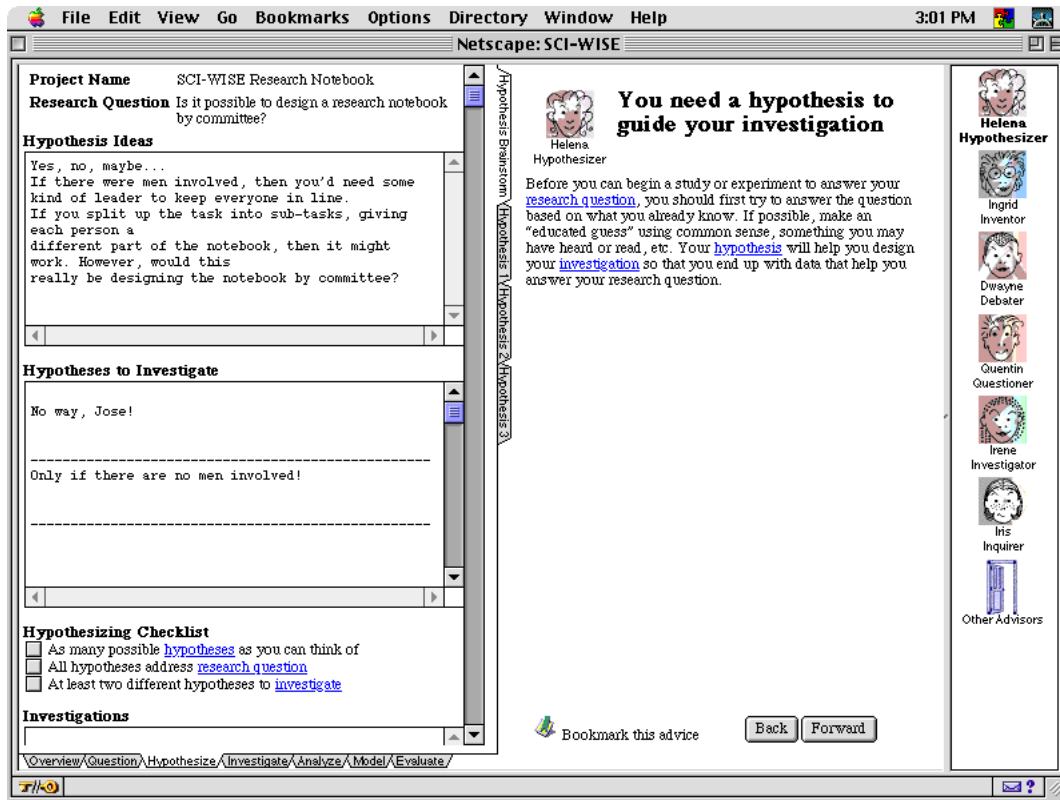

Figure 1 - SCI-WISE User Interface

Artifact Pane

The artifact usually appearing in the artifact pane is the Research Notebook, which directly scaffolds progress through the Inquiry Cycle. Each task within the cycle gets at least one page in the notebook, and the user can navigate to the page for a specific task via the tabs appearing along the bottom edge of the artifact pane. If a task requires more

than one page, additional tabs appear along the right edge of the artifact pane. Normal browser navigation (Forward, Back, etc.) is disabled for the artifact pane, and any links appearing within this pane instead cause pages to be loaded into the advice pane. This prevents inappropriate pages from being loaded into frames other than the advice pane.
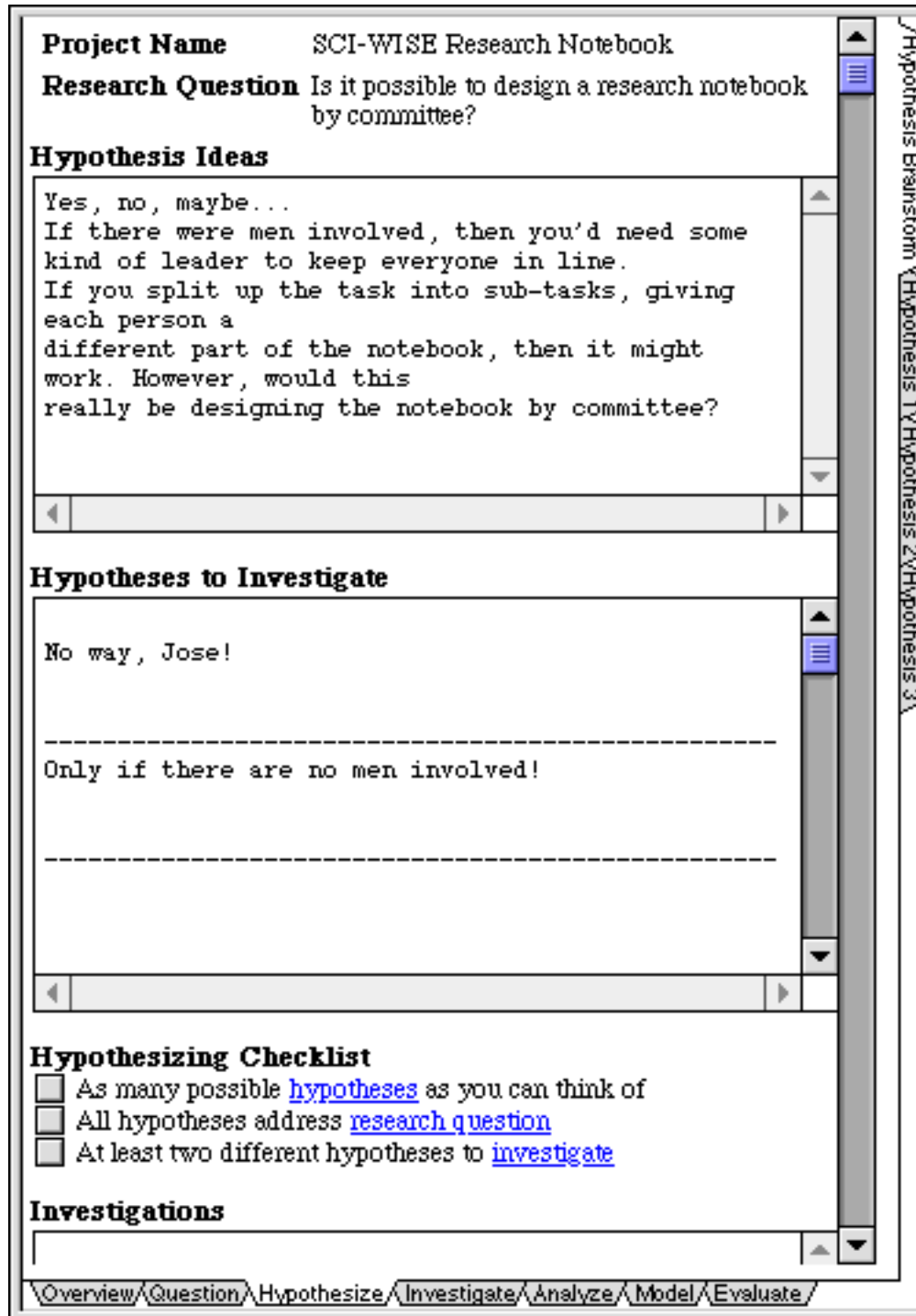

Figure 2 – Artifact Pane

Advice Pane

Only one piece of advice is displayed at a time in the advice pane. Each piece of advice is stored in a separate HTML page, which may contain text, hyperlinks, pictures, video, or any other media supported by internet browsers. Each potentially unfamiliar term or phrase in an advice page is appropriately hyperlinked to another page defining and elaborating the concept. In addition, advice HTML is extended to support a set of SCI-WISE specific tags (encapsulated within HTML comments). These tags allow the SCI-WISE web server to insert special objects into the HTML stream it sends to the browser, such as the user's name, the title of their first hypothesis, etc. Normal browser navigation (Forward, Back, etc.) is limited to the special navigation buttons appearing along the bottom edge of the advice pane. This prevents the user from loading inappropriate pages into browser frames other than the advice pane.

You need a hypothesis to guide your investigation

Helena Hypothesizer

Before you can begin a study or experiment to answer your research question, you should first try to answer the question based on what you already know. If possible, make an "educated guess" using common sense, something you may have heard or read, etc. Your hypothesis will help you design your investigation so that you end up with data that help you answer your research question.

Bookmark this advice   Back | Forward

Figure 3 – Advice Pane

Each page of advice includes the advisor's icon, and begins with an Advice Summary, a single phrase summarizing the advice (e.g., "Two hypotheses are better than one.") Pieces of advice are identified by their advice summaries, rather than the filename of the HTML source or some other cryptic identifier. Advice summaries are important for

developing rules specifying when the advice is relevant, as described in the Rules section below.

The HTML page displayed in the advice pane can be changed only when specifically requested by the user (e.g., when they click a link within the advice or artifact panes, or agree to accept a piece of advice offered by an advisor.) This eliminates the need for advisors to figure out when the user is finished reading a piece of advice.

Advisory Team Pane

Only a subset of the complete set of SCI-WISE advisors is active (thinking about what advice to offer the user) at any time. This team is assembled (and the advisors activated) by the Team Leader advisor. There is a different leader for each step within the Inquiry Cycle (e.g. Quentin the Questioner, Helena the Hypothesizer, etc.), and the appropriate leader is activated whenever the user switches pages in the Research Notebook. Advisors who are not part of the current team may be accessed through the Other Advisors icon at the bottom of the advisory team pane.

Figure 4 – Advisory Team Pane

As noted above, advisors do not have direct control over the advice pane. Instead they place advice into the pane in response to user requests. There are three methods for doing so: the user can ask an advisor for a piece of advice, the advisor can alert the user that it

has a relevant piece of advice, or the advisor can interrupt the user with a request to display a relevant piece of advice.

When configured in ask mode, an advisor simply maintains an ordered list of the advice pages it feels are most relevant given the current situation. This list can be accessed by the user only if they click on the advisor in the advisory team pane, which places the advisor's introductory page into the advice pane, and then click the Give Advice button in that page. The user may access all of the advisor's advice by clicking the Look for Advice button, which displays the Find Advice page, supporting both keyword and full-text searching of the advisor's advice database. The Find Advice page also contains the topmost links for the Advice Taxonomy, a set of intermediate pages that provide an appropriate organization for the advice, eventually linking to each page of it.

When configured in alert mode, an advisor with relevant advice modifies its icon in the advisory team pane so that it conveys this impression to the user (e.g., it changes color, vibrates, waves, etc.) If the user moves the mouse cursor over an alert mode advisor with relevant advice, a text balloon appears containing the advice summary for the most relevant piece of advice. If the user clicks the Details button in the balloon, the associated advice page is displayed in the advice pane.

When configured in interrupt mode, an advisor with relevant advice dispenses with subtlety and displays the advice summary balloon without any user action.

Advisor Reasoning

Each advisor is implemented as a separate thread within a single Java application running alongside the user's internet browser. The advisor controls its appearance in the advisory team pane and places advice pages into the advice pane by communicating with a Java applet embedded in the main SCI-WISE browser page. Each agent thread is a combination of custom Java code, a JESS (Java Expert System Shell, a Java implementation of CLIPS) reasoning engine, and JESS code specifying rules for the agent's behavior. Some of the JESS rules provide a architectural framework for the behavior of a prototypical agent, and are therefore "hard-coded." Beyond this basic architectural set, all rules specifying the behavior of the agent (e.g., its goals and strategies for achieving them, its beliefs about the user or the relevance of a piece of advice, etc.) can be viewed and edited by the end user using a graphical user interface (as opposed to a programmatic one).

Beliefs

A belief is a primitive statement about something that the advisor thinks is true (e.g., "The user has entered only one hypothesis into the Research Notebook.") Some beliefs are asserted by the system architecture. For example, when the user types a hypothesis into the Research Notebook, it asserts the belief described previously. Other beliefs are asserted as a consequence of one of the advisor's rules firing (e.g., "If student 1 is female and student 2 is male, then the students have different genders.")

Concepts

Beliefs typically fall into mutually exclusive sets. For example, it wouldn't make sense for an advisor to simultaneously believe that "The user has entered only one hypothesis into the Research Notebook," and "The user has entered only two hypotheses into the Research Notebook." Concepts are the mutually-exclusive groups into which beliefs fall (e.g. "the number of hypotheses entered into the Research Notebook.") Often, none of the beliefs associated with a given concept will be asserted. In this case, the advisor doesn't know which of the beliefs might be correct.

Rules

The "intelligence" of advisors is represented as simple if-then rules. Beliefs are the inputs to rules; their consequents can include other belief assertions (including beliefs that a particular piece of advice is currently relevant), messages sent to other advisors, changes to its own appearance in the advisory team pane, etc.