DIOPTRA: AN ETHICS DECISION SUPPORT SYSTEM

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Abstract

Ethical decision making is difficult. Decision makers with cognitive, emotional, social, and philosophical limits have incomplete information about ambiguous, dynamic situations, where the consequences of action are uncertain. This paper describes Dioptra, a decision support system that can help people become more effective ethical decision makers. Dioptra adds structure to the decision process, supports various communication modes from face-to-face to fully distributed teams, helps DMs avoid cognitive and other biases, and addresses dysfunctional group behavior. Dioptra is a flexible system, potentially useful for many other applications besides ethical decision support. However, Dioptra is intended to be used by mindful people in organizations with an ethical culture. The system will be of limited use if these conditions are not met.

Keywords: ethics, DSS, design science, dilemma, problem structuring, cognition, group dynamics, mindfulness

Introduction

Suppose that a company seriously commits to acting ethically. Top management follows the policy, leading by example. The firm changes its hiring practices, training procedures, compensation methods, and so on, to match the new policy. The company genuinely embraces ethics, making it standard business practice.

Google claims to have done something like this. Their "statement of principles [is] meant to inform all our actions; we expect all our employees … to study these principles and apply them to any and all circumstances which may arise" (http://investor.google.com/conduct.html). Google's informal motto is "don't be evil."

However, even though employees understand their firm's ethics policy, and are motivated to follow it, they might have difficulty making decisions consistent with it. Some ethical problems are "wicked." Wicked problems are ambiguous, and occur in complicated and ill-defined environments

(Hevner, March, Park, and Ram, 2004). It is very difficult to obtain optimal solutions to wicked problems. In fact, it may not even be possible to define what "optimal" means.

The wickedness has three basic sources. The first has to do with ethics itself. Centuries of discussion have not produced broad agreement on ethical problem solving. Even basic terms like "good" do not have universal definitions. Further, ethics touches things that are central to human meaning, like religion, family, and justice, all of which are contentious.

The world's complexity is the second source of wickedness, particularly when it gives rise to ethical dilemmas. A dilemma is a situation that sets right against right, or wrong against wrong. The abortion debate pits life (something people value) against freedom (something also valued). Assisted suicide pits suicide (which most would say is bad) against terminal suffering (another bad thing). Kidder (1996) writes that some dilemmas are particularly common in business: truth vs. loyalty, individual vs. community, short-term vs. long-term, and justice vs. mercy.

No matter how well-informed, wise, and "good" the decision maker (DM), he or she will be open to criticism no matter what action is taken. For example, Google faced a dilemma in China: to offer search services limited by Chinese government policies, or to offer no service at all (BBC News, 2006). Google could be accused of violating its "don't be evil" motto no matter what it did. Even perfect DMs with perfect information face no-win situations.

The third source of wickedness is that there is no such thing as a perfect DM with perfect information. Ambiguity is the norm. We don't know why people act the way they do, what they want, or can even be certain that they know what they want. We often don't know the full history behind a particular situation. We don't know what actions are available to us, or what will happen if we choose a particular action. Further, DMs are subject to cognitive, emotional, social, and philosophical biases. Note that this isn't a question of motivation. Ethical decision making is difficult, no matter how motivated DMs are. Decisions must be made, however; ethically ambiguous situations cannot be avoided. Someone has to decide what to do.

This paper describes Dioptra, an ethical decision support system (EDSS). Dioptra doesn't make any choices itself. Instead, it helps individuals and groups become better decision makers. Dioptra adds

structure to the decision process, supports various communication modes from face-to-face to fully distributed teams, helps DMs avoid biases, and addresses dysfunctional group behavior. The system will help ethically motivated DMs consistently behave ethically.

The system is based on theoretical principles discussed by Mathieson (2007), who reviewed ideas from cognitive, emotional, social, and moral psychology, philosophy, business ethics, MIS, theology, and other fields. Dioptra doesn't implement all of that paper's ideas, but does cover the most important ones. Perhaps the only comparable work being done today is reported by Robbins and Wallace (2006). Their approach leans more towards the artificial intelligence and philosophy literatures, while Mathieson (2007) borrows more from the behavioral sciences.

The discussion proceeds as follows. First, the system's usage context is considered, and its goals *vis-à-vis* that context explored. Second, Dioptra's main features are examined, grouped into four categories: problem structuring, communication, cognitive support, and group support. Third, the system's architecture is described, with special attention to securability. Finally, its use as a research and teaching tool is considered.

Any discussion of ethics raises many questions, such as "Why should people be ethical?," "Why should companies worry about ethics?," "Who gets to say what is ethical?," and "Is ethics just personal preference?" The literature on these questions goes back at least 2,500 years. I beg the reader's indulgence in focusing on Dioptra. The deep questions of ethics are *very* important, but it is impossible to do them justice here. Liszka (2002) is a good entry point into ethics and the Great Conversation.

Usage Context

Circumstances limit the potential effectiveness of any DSS. This may be particularly true of ethical decision making, which makes strong demands of DMs and organizations. This section considers the context within which Dioptra could be effective.

The question of what "effective" means is complex. Unless one commits to a particular religious or philosophical perspective, "effective" is best defined in terms of process. That is, effective decisions are made using disciplined processes that avoid individual, group, and organizational biases. See Mathieson (2007) for more information.

Organization

Organizational support for ethics affects employee behavior (O'Fallon and Butterfield, 2005), perhaps more than personal characteristics (Banerjee, Cronan, and Jones, 1998). Employees of firms with ethical codes, supportive statements from top management, and penalties for misconduct are more likely to make ethical choices than employees of other firms (Laczniak and Inderrieden, 1987).

Dioptra may not be effective in firms that do not take ethics seriously. Even if system use is required, it may become an exercise in justifying decisions that have already been made, rather than a true search for ethical solutions. The rest of the discussion assumes that Dioptra is being used in companies committed to ethics.

DMs

It is assumed that DMs accept a personal responsibility to be ethical. If they do not, they may see Dioptra use as a waste of time. This does not mean that DMs are perfect. People are always affected by their cognitive processes, intelligence, emotions, goals, and so on. In complicated social and emotional situations, it helps if DMs are self-aware, that is, able to detect and ameliorate emotional and cognitive biases (Mathieson, 2007). For example, self-aware DMS might avoid premature judgment, take other people's perspectives into account, and be open, agreeable, and conscientious.

Complete self-awareness is rare, if it exists at all. It is something to aspire to, rather than a realistically achievable goal. We can say, however, that Dioptra's potential effectiveness is limited by DM self-awareness. There may be a threshold below which Dioptra is useless.

Need for Decision

Not all ethical decisions are complicated. If you find a sack of money, it isn't difficult to work out what you should do. There is no need for a DSS. It is assumed that Dioptra is used only in complicated, ambiguous situations, where the risk of a mistake is significant.

Features

Let's turn to the features of the system. The discussion is organized around four feature categories: problem structuring, communication, cognitive support, and group support. Communication and group support could be pooled into one category, but it is more convenient to discuss them separately. The

communication features focus on information exchange, while the group support features address problems in group dynamics.

Problem Structuring

DMs can spend much effort just understanding fuzzy problems (Zigurs and Buckland, 1998). Dioptra helps by offering a general framework for ethical problem solving. It is important to avoid imposing too much structure. Dioptra could force DMs to follow a single philosophical method - utilitarianism, deontology, virtue, divine command, or something else (see Mathieson, 2007, for a discussion). In practice, however, DMs want to mix-and-match various techniques (Thong and Yap, 1998; Robbins, Wallace and Puka, 2004). Dioptra offers enough structure to help DMs identify important issues in ethical analysis, without being so inflexible that it prevents DMs from controlling the decision process.

Figure 1 shows the overall structure of a Dioptra analysis. There are five main sections. The first is elaboration. It helps DMs understand the situation, which may not be as it first appears. For example, suppose that Sarah is Gary's supervisor. She might be upset on learning that Gary left the office for the afternoon. Her ire might turn to gratitude if she learns that Gary visited an important customer on his own initiative, to solve a problem that could have cost Sarah dearly.

The next section, analysis, is the core of the decision process. DMs break down the situation into components for easier study. The next section is choice, where DMs select one or more actions. In the synthesis section, DMs tell the "future story" of their decision, predicting the effects of their chosen actions. Finally, in the explanation section DMs justify their decision to others. People work more assiduously when they know they will have to explain their actions (Kunda, 1999). Dioptra helps DMs by generating a PowerPoint-like presentation from their input.

Two sections are broken down further. Elaboration has two subsections: the situation as originally presented to DMs, and their final understanding of it. Figure 2 shows an elaboration of Heinz's dilemma, often used in moral development research.

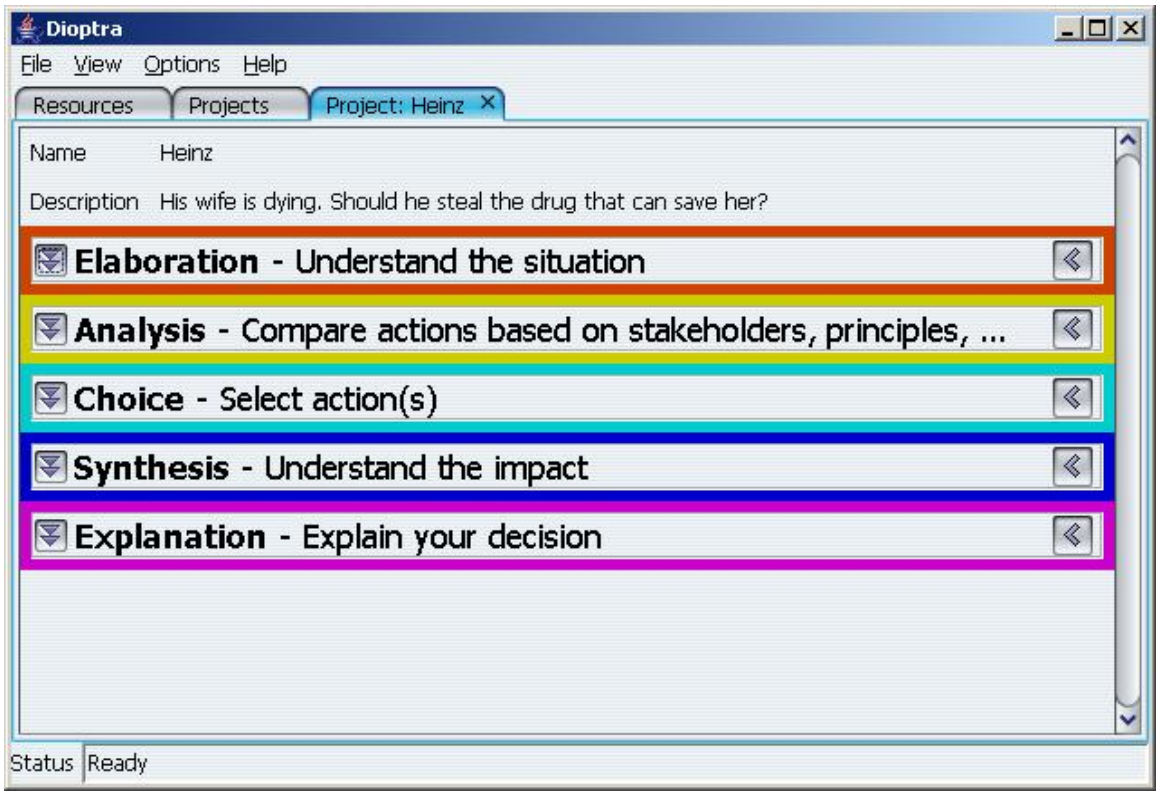

Figure 1. Problem Structure

Analysis has five subsections (see Figure 3), using concepts identified by Mathieson (2007). The actions subsection identifies things the organization might do. The stakeholders subsection lists those who have an interest in the outcome. The principles subsection lets DMs identify moral principles they would like to consider, like justice or caring. Virtues and divine commands would also be included here (they are not "principles" in the usual sense of the word in ethics, of course, but it is convenient to include them here with other abstractions used in deduction). The heuristics subsection lists rules of thumb for evaluating actions, such as "would you like to see your decision reported in the newspaper?" Finally, the grid is a two-dimensional matrix that helps DMs compare actions. It has actions as columns, and stakeholders, principles, and heuristics as rows. Mathieson (2007) left open the option of higher dimensional structures, such as a three-dimensional action/principle/stakeholder matrix. Dioptra uses a two-dimensional approach for simplicity.

Note that *everything* is optional. DMs are not required to complete particular sections or subsections. Dioptra lets DMs use mixed strategies, assembling pieces as they see fit. The EDSS is *never* in charge; it is up to the DMs to formulate specific decision strategies.

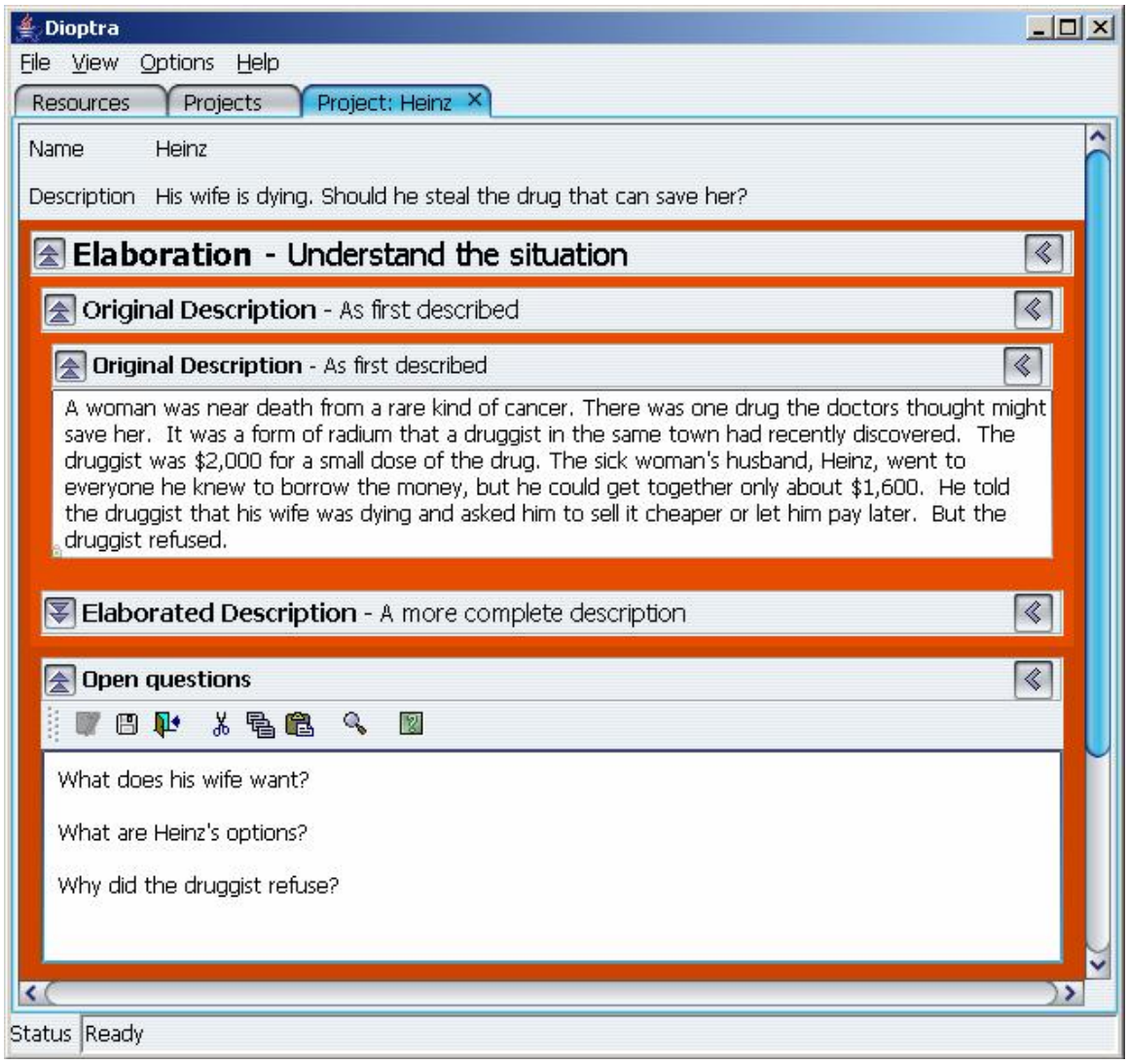

Figure 2. Elaboration

Every section and subsection is a container that holds various tools. Every container has a similar format, as shown in Figure 4. An arrow button on the right of each title area shows or hides a toolbar. In the toolbar, a combo box lists the types of things that can be added to the container, with different containers allowing different components. For example, all that can be added to the actions subsection are actions, like "Steal the drug" or "Let wife die." However, once an action is added, it has its own container called a toolstack. DMs can add as many tools to toolstacks as they wish.

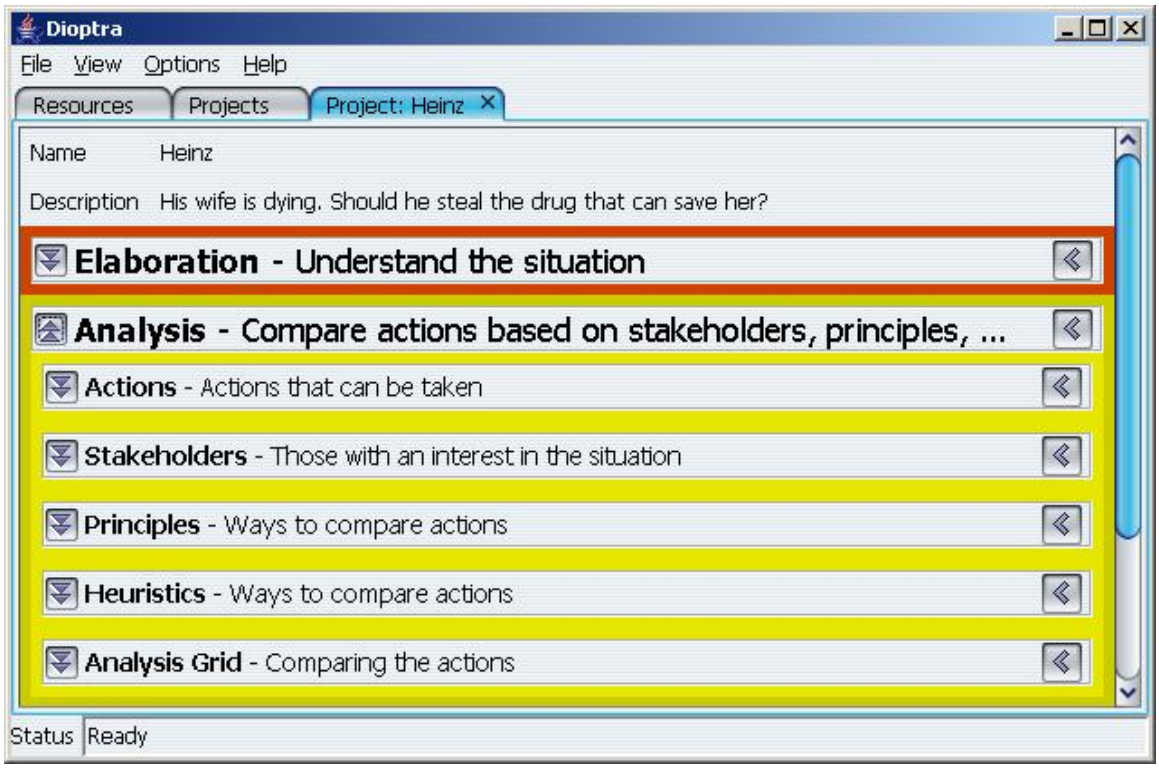

Figure 3. Analysis

Figure 5 shows the types of tools that are available. An editor is a plain text editor, with search, drag-and-drop, unlimited undo, and other features. A brainstormer supports anonymous brainstorming, where DMs add ideas to a cumulative set. Voters let DMs anonymously vote on options. Chat is anonymous or attributed (that is, not anonymous) real-time text chat. The forum is similar, but is not real-time.

The two controls on the right of the toolbar in Figure 4 help DMs present their work. If the box is checked, that element will be included in the presentation. The second control determines the size of the font that will be used for that item in the presentation. This simple approach gives DMs flexibility, without requiring them to learn a complicated set of presentation features. All they need do is select tools for a presentation, choose a presentation template (which controls font faces, color schemes, and so on, like a PowerPoint template), and Dioptra will do the rest.

DMs select the tools they want in each section, based on the situation, and their own decision processes. If there is little disagreement on, say, stakeholder 1, DMs might add only a single editor in that section. If DMs find that stakeholder 2 warrants more discussion, they might find it useful to add an editor,

a chat, a brainstormer, and a voter. The complexity of an analysis, as measured by, for example, the total number of tools across all sections, grows or shrinks as DMs work through a project.

Figure 4. Adding an Action

Figure 5. Adding a Tool

In the *Sciences of the Artificial* (Simon, 1969), Herbert Simon wrote about an ant wandering on a pebble beach. Suppose you were to plot the ant's path over time (See Figure 6). It would be complex, as the ant turned, backtracked, climbed up some pebbles and down others, and so on. A mathematical function fitting the path would be complex as well. However, ants are simple creatures, and use simple rules. The complexity in the ant's path comes not from the ant, but from the ant's simple rules interacting with a complicated environment, that is, a pebble beach filled with slopes, shadows, etc.

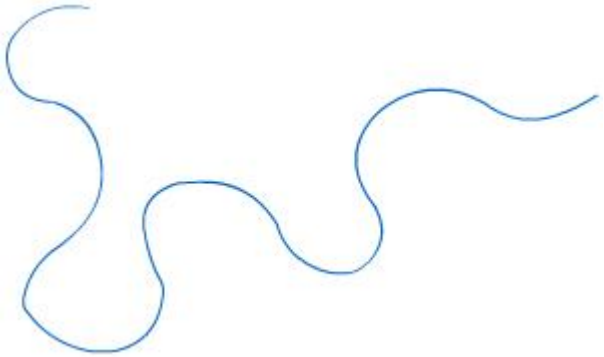

Figure 6. An Ant on a Pebble Beach

Something like this happens with Dioptra. All of the system's tools are quite simple individually. DMs add them as required to help them deal with potentially complicated situations. The result can be a

complicated quilt of tools. The complexity does not arise from the software, which is fairly simple in both concept and use. The complexity arises when DMs employ the tool to address complicated situations.

An interesting characteristic of Dioptra is that it inverts the usual relationship between technology and content. With other systems, content about a particular issue (e.g., the interests of stakeholder 1) is split across technologies, such as email, a discussion forum, a chat room, a text document, etc. Users open a tool first (e.g., they open a discussion forum) and then locate that fragment of issue content that is managed by that tool. The content about stakeholder 1 is mixed in with content about other issues that have been discussed in the forum. Examining another fragment of content about stakeholder 1 requires opening a different tool (e.g., a chat room's records), and finding the content about stakeholder 1 that is mixed in with content about other issues. So, in other systems, there is one instance of each tool, and content is distributed across tools.

In contrast, Dioptra keeps all content about an issue together, and breaks up the tools. The discussion of stakeholder 1 might have a chat room and a text summary. Discussion of stakeholder 2 might have its own chat room, text summary, brainstormer, and voter. There is one place for content about an issue, and multiple instances of tools, distributed across content areas. In Dioptra, tools are subservient to content.

Communication

Communication is integrated into the problem framework. Every tool is a potential communication device. For instance, a DM might add an editor, with a few paragraphs about Heinz stealing the drug. Other DMs could change the text. The editor helps DMs coordinate their work.

Most of the tools are append-only. For example, new chat messages are added to the existing list, without changing older messages. However, the editor requires more coordination, to prevent changes made by one DM from accidentally overwriting changes made by another. Dioptra uses a check-out/check-in model to handle editing concurrency. That is, only one DM can change an editor's text at a particular moment. Figure 7 shows three different states of an editor's toolbar. The first one shows that the text is available for editing. Clicking the edit button checks the editor out to that DM, sending the toolbar into the second state. While this DM is working, other DMs see the toolbar in the third state, showing that it is locked. As edits are saved, changes are sent to other clients in real time.

Figure 7. Editor Toolbar States

DMs need to keep up-to-date on a project's status. When they open a project, they are given a list of things that have changed since their last log in. DMs are also told about real-time changes, that is, changes made to one part of the project while they have been working on another (this can happen when two or more DMs are working on a project simultaneously). DMs can also add messages to the change list. For example, a DM might add a message asking other DMs for their feedback on a change.

Finally, there is a shout box that lets DMs send instant text messages to other DMs working on the same project at the same time. They can use shout messages to, for example, ask people to join a chat session. So, Dioptra supports synchronous communication as well as asynchronous communication.

Cognitive Support

Mathieson (2007) identified cognitive biases that affect decision making, including anchoring and adjustment, availability, attribution errors, and overuse of stereotypes. Dioptra does not try to "solve" these problems; it isn't intelligent enough to do so. Instead, Dioptra helps DMs be mindful of these issues as they work.

Every section, subsection, and tool has two types of user assistance. The first is the usual interface help found in traditional help files, showing what the buttons do, and so on. The second form of assistance is advice about ethical decision making, called pointers. Pointers are specific to the location of the section, subsection, or tool in the solution structure. For example, stakeholder pointers warn DMs about making assumptions about stakeholder's actions without sufficient evidence (attribution error). A pointer in the

choice section warns DMs against satisficing, that is, choosing the first action this is marginally acceptable, rather than spending time looking for better solutions.

Pointers contain links to documents in the resource tree, a collection of content about ethical decision making. For example, a pointer in the principles subsection links to an article on virtue ethics, summarizing ideas from Plato, Aristotle, and others. Another article explores religious duties, identifying rules common to many religions, such as "love your neighbor as yourself" (often called the Golden Rule). DMs can attach their own notes to resource tree articles.

The cognitive support Dioptra offers is advisory. DMs are assumed to be informed, well-intentioned, and mindful. If they are not, there is little that Dioptra or, arguably, any decision tool can do. Dioptra can help DMs think, but it cannot think for them.

Group Support

Dioptra uses ideas from group DSS research. For example, people are more likely to criticize ideas, ask questions, and add their own thoughts when they work anonymously (Jessup, Connolly, and Galegher, 1990). Dioptra supports anonymity in its editor, brainstormer, chat, forum, and voter tools.

However, Dioptra warns DMs about the costs of anonymity, including social loafing (Jessup et al., 1990; Nunamaker, Dennis, Valacich, Vogel, and George, 1991), and deindividuation (Haney, Banks, and Zimbardo, 1973). The resource tree has articles on these issues. It is up to informed, well-intentioned, and mindful DMs to decide when to use anonymity features.

Architecture

This section briefly outlines the system's architecture. To keep the paper's length reasonable, it is assumed that the reader is familiar with technical issues and acronyms.

Client

Dioptra's rich clients and relatively simple server communicate using a custom protocol built on XML-RPC. The client is written in pure Java. Apart from the JDK, it uses open source software like the Substance look-and-feel package. Java was chosen because it is open, well-known, performs well, allows user interfaces to be highly customized, and is free. Java applications are also easy to deploy. Further,

because of Java's strong typing, object orientation, and sophisticated development environments, Java applications tend to be more robust than, for example, JavaScript applications.

DMs can open many projects at a time. Each is given its own tab in the interface (see Figure 1). There are also tabs for the project list and the resource tree. DMs can even open the same project in more than one tab. Dioptra treats each tab as a separate process for coordination purposes.

Server

The server was designed with economy, ease of deployment, and securability in mind. It is written in PHP, and uses the MySQL DBMS. Even inexpensive Web hosting accounts, costing perhaps $15/month, offer PHP and MySQL as standard. The server was designed with LAMP (Linux/Apache/MySQL/PHP) environments in mind, although it also works on Windows. LAMP installations are scalable, running on everything from obsolete PCs to mainframes.

Dioptra is easy to deploy, and can be configured in many different ways. A Dioptra "server" is a single directory on a Web server, plus a MySQL database. Thus, one Web server (e.g., an Apache instance) and one MySQL server (i.e., one instance of the MySQL engine) can support dozens of Dioptra server instances.

Securability

Dioptra takes a rather draconian approach to securability. All client/server communication is encrypted by the application, in addition to other mechanisms the network infrastructure might use (such as SSL). Each Dioptra server instance can use a different Blowfish pass phrase, even though many Dioptra server instances might be running on the same Web server. All communication is *via* HTTP. Every transaction is authenticated separately, honoring HTTP's connectionless nature.

Dioptra clients are securable. In the extreme, Dioptra can be run on inexpensive computers in a locked room running, say, stripped-down Linux, and no other applications. Dioptra clients require only a JRE (Sun 1.6), a single JAR file, a properties file, and a few resource files. No user names or passwords are cached on the client.

On the server side, Dioptra is designed to run on older, stable versions of PHP (version 4.3), MySQL (version 4.1), and Apache (version 1.3). These tools are unlikely to require security patches. The

PHP scripts use no special binary libraries. Tools like database abstraction software (e.g., PEAR's MDB2) are not used. This locks the server into MySQL, but eliminates database abstraction software as a source of security risks. Given the ubiquity of MySQL, the tradeoff is worthwhile.

The PHP scripts do not require write access to even a *single* file or directory. All state information is stored in the database, as are all logs. PHP developers may be surprised to learn that Dioptra does not use session variables *at all*. They might be a security risk, albeit a small one, on improperly configured shared hosts. PHP's session mechanism also requires special treatment on server clusters, to make sure that the same session file is accessed, no matter which server is running a script. Again, security problems are unlikely when the shared session mechanism is properly implemented. However, avoiding session variables means that even these small risks are avoided.

Using Dioptra for Research and Teaching

Although Dioptra was designed for business applications, it may also be useful for research and teaching. The detailed logs Dioptra keeps could help researchers study ethical decision process. They could test hypotheses about DM characteristics (like ethics training, self-awareness, and emotional maturity), decision situations, firm culture, reward systems, time constraints, communication styles, geographical distance, and many other variables. For instance, it would be interesting to see how decision processes vary with philosophical sophistication.

Dioptra could be a valuable teaching tool, for corporate training as well as university education. Students could examine their own decision methods, see how they relate to ethical theories, and compare their choices with those of others. Students at different universities, or different locations in a firm, could work together. This might force them to be more explicit about their thinking, since the nonverbal exchanges of face-to-face communication would have to be represented in text.

Dioptra addresses ethical decisions because the author sees a particular need in this domain. However, the general approach is not limited to ethical decision making. Its mechanisms - sections, subsections, tools, the resource tree, etc. - are quite general. The current section list (elaboration/analysis/choice/synthesis/explanation) could be replaced with intelligence/design/choice

(Simon, 1977), or some other set of steps. The current toolset could be augmented by, for example, numerical tools for calculating return on investment, optimal order quantity, regression weights, and so on.

Conclusion

Dioptra helps individuals and groups make ethical decisions. It is based on theoretical ideas from Mathieson (2007). Dioptra is intended to be used by self-aware people in organizations with an ethical culture, who face a complicated, ambiguous situation. It may be of little use if these conditions are not met.

Dioptra uses a rich client and a simple server. It is easy to deploy. Securability was important in its design. Its tools are general, and could be adapted to situations besides ethics.

Do businesses want something like Dioptra? Frankly, I don't know. Some business leaders are making ethics a priority (Business Week, 2006), but it isn't clear how broad this movement is. Creating an ethical culture forces managers to face difficult human issues they may prefer to leave buried. For example, moral differences can divide groups more sharply than ethnic, racial, or other differences (Haidt, Rosenberg, and Hom, 2003). No doubt many managers prefer to keep ethical tensions below the surface. However, managers are not all alike. Those with progressive ideas about business and personal development (e.g., as outlined by Senge, 1990), may be interested in at least trying an ethical DSS. Further, there may be managers in the public and non-profit sectors who would be interested in Dioptra.

Dioptra is a work-in-progress. Features will be added, changed, and dropped as more is learned about ethical decision making. Of course, it may be that Dioptra is useless for real organizational work. Time will tell.

References

Banerjee, D., Cronan, T. P., and Jones, T. W. "Modeling IT Ethics: A Study in Situational Ethics," MIS Quarterly (22, 1), 1998, pp. 31-60.

BBC News, "Google Censors Itself for China," 25 January 2006, http://news.bbc.co.uk/1/hi/technology/4645596.stm, accessed February 16, 2007

Business Week, "Calling the Ethics Cops", February 13, 2006, http://www.businessweek.com/magazine/content/06_07/b3971113.htm, accessed 7/Feb/2006.

Haidt, J., Rosenberg, E., and Hom, H. "Differentiating Diversities: Moral Diversity Is Not Like Other Kinds," Journal of Applied Social Psychology (33, 1), 2003, pp. 1-36.

Haney, C., Banks, W. C., and Zimbardo, P. G. "Interpersonal Dynamics in a Simulated Prison," International Journal of Criminology and Penology (1), 1973, pp. 69-97.

Hevner, A. R., March, S. T., Park, J., and Ram, S. "Design Science in Information Systems Research," MIS Quarterly (28, 1), 2004, pp. 75-105.

Jessup, L., Connolly, T., and Galegher, J. "The Effects of Anonymity on GDSS Group Process With an Idea-Generating Task," MIS Quarterly (14, 3), 1990, pp. 313-321.

Kidder, R. How Good People Make Tough Choices, New York: Fireside, 1996.

Kunda, Z. Social Cognition, Cambridge, Massachusetts: MIT Press, 1999.

Laczniak, G. R., and Inderrieden, E. J. "The Influence of Stated Organizational Concern Upon Ethical Decision Making," Journal of Business Ethics (6, 4), 1987, pp. 297-307.

Liszka, J. Moral Competence: An Integrated Approach to the Study of Ethics, second edition, Upper Saddle River, New Jersey: Prentice Hall, 2002.

Mathieson, K. "Towards a Design Science of Ethical Decision Support," forthcoming in the Journal of Business Ethics, 2007.

Nunamaker, J. F., Dennis, A. R., Valacich, J. S., Vogel, D. R., and George, J. F. "Electronic Meeting Systems to Support Group Work," Communications of the ACM (34, 7), 1991, pp. 40-61.

O'Fallon, M. J., and Butterfield, K. D. "A Review of The Empirical Ethical Decision-Making Literature: 1996-2003," Journal of Business Ethics (59, 4), 2005, pp. 375 - 413.

Robbins, R. W., and Wallace, W. A. "Decision Support for Ethical Problem Solving: A Multi-Agent Approach," forthcoming in Decision Support Systems, 2006.

Robbins, R. W., Wallace, W. A., and Puka, B. "Supporting Ethical Problem Solving: An Exploratory Investigation," Proceedings of the 2004 SIGMIS Conference on Computer Personnel Research, Tucson, Arizona, 2004, pp. 134-143.

Senge, P. M. The Fifth Discipline, New York: Currency Doubleday, 1990.

Simon, H. A. The Sciences of the Artificial, Cambridge, Massachusetts: MIT Press, 1969.

Simon, H. A. The New Science of Management Decision, revised edition, Upper Saddle River, New Jersey: Prentice Hall, 1977.

Thong, J.Y.L., and Yap, C. "Testing an Ethical Decision-Making Theory," Journal of Management Information Systems (15, 1), 1998, pp. 213-237.

Zigurs, I., and Buckland, B. K. "A Theory of Task/Technology Fit and Group Support Systems Effectiveness," MIS Quarterly (22, 3), 1998, pp. 313-334.