ABSTRACT

Virtual collaboration through online collaboration systems that provide shared workspaces is becoming increasingly commonplace in today’s organizations. Recent research has focused on identifying and describing patterns of collaborative activity. Current observation methods of collaborative work are mostly manual and labour-intensive. We propose using the shared workspace system itself to collect and make available observations of virtual work. We propose the notion of patterns of virtual collaboration as aggregations of detailed activities into larger-scale units, and distinguish several different levels of abstraction. We illustrate the use of patterns of virtual collaboration on an actual shared workspace system, and discuss other potential applications.

KEY WORDS
pattern, virtual collaboration, shared workspace, groupware

1 Introduction

Virtual collaboration, the practice of teams of people working across boundaries of time, space, and organization, and aided by information and communication technology [1], is becoming increasingly commonplace in today’s organizations. One of the ways in which virtual teams work together is through shared workspaces. A shared workspace is a virtual space which provides the opportunity for bringing together people, artefacts, and communication channels for individual or joint activity. A shared workspace system is a software system that supports virtual collaboration through the provision of shared workspaces. Shared workspace systems may support synchronous, i.e. same-time, or asynchronous, i.e. different-time, activity, while some systems support both of these modes of collaboration. Recent examples of shared workspace systems include BSCW [2], LiveNet [3], Orbit [4], and TeamRooms [5].

Recent research in virtual work has focused on identifying and describing patterns of activity in cooperative and virtual work [6, 7, 8]. Most of these studies take an ethnographic approach, involving laborious manual collection and analysis of data. This paper proposes a form of observation obtained from the collaboration system itself, which we term patterns of virtual collaboration, that can be thought of as aggregations of detailed activities into larger-scale units.

Such representations have the potential to serve as work situation descriptions, to follow the terminology of Kyng, which “are interpreted by people who already have knowledge of the situations described and who, if necessary, can revisit similar situations to improve their understanding” [9, p. 49]. Moreover, obtaining such patterns of activity in virtual collaboration aims at making work more visible, with its attendant benefits: “Things are made visible so that they can be seen, talked about, and potentially, manipulated” [10, p. 63]. Abstract representations of virtual collaboration are useful in providing a high-level view of joint activity to the various stakeholders: those directly involved in the collaboration, as well as those not involved but with an interest in it (such as management).

This paper continues as follows: the next section briefly reviews related work on patterns, and then presents our own model of patterns of virtual collaboration. Section 3 illustrates the use of our pattern model to the LiveNet collaboration system, and Section 4 presents conclusions.

2 Patterns

Shared workspace systems have the potential to be a rich source of information about the work carried out through them, once they are instrumented to collect data about the activities of their users. Before going into details of our notion of patterns, we briefly review related work.

2.1 Related Patterns Work

The idea of patterns has been applied to the broad domain of collaboration by a number of researchers. These can be broadly grouped in two categories: patterns as prescriptions for work, and patterns as descriptions of actual work practice. In the prescriptive sense, Coplien and his colleagues investigated the software development process, compiling a collection of patterns of productive software organizations [11, 12]. Briggs and his colleagues have cre-
ated the notion of thinkLets as patterns of group facilitation within the domain of Group Support Systems (GSS) [13]. In the domain of workflows, the notion of workflow patterns as basic building blocks of workflows has recently been proposed [14]. Finally, IBM has developed a set of e-business patterns—architectural patterns used in the construction of e-business systems, including those facilitating collaboration—together with a methodology for applying them [15].

For patterns in the descriptive sense, Erickson has suggested the use of pattern languages for making the results of workplace studies more easily reusable [16]. In a similar vein, Martin and his colleagues have suggested the use of patterns of cooperative interaction to understand human interaction, where the patterns are drawn from ethnographic studies of work environments [7].

2.2 Patterns of Virtual Collaboration

Our patterns are primarily patterns in the descriptive sense, i.e. structures in a pre-existing body of data that can be extracted using techniques of data mining, and that can be explored through information visualization. Descriptive patterns, once discovered and extracted from a body of data, have the potential to serve as sources for reuse, i.e. serving as prototypical prescriptions for use [17].

2.2.1 Basic Notions

A pattern in the descriptive sense is an abstract description of a structure existing in a body of data. For the patterns considered here, the body of data is related to virtual collaboration and originates from a shared workspace system. It contains details of users, shared workspaces, artefacts, communication channels, etc., as well as certain relationships among these. This data is interpreted to yield information, by applying pre-existing knowledge about the meaning of certain data items within the context of the given shared workspace system.

This information is of two types: firstly, information relating to entities within the shared workspace system, which we refer to as static-type information. Secondly, information about the actions that take place within the shared workspace system, which we refer to as dynamic-type information. Static-type information represents structures of virtual space, while dynamic-type information represents behaviour associated with those structures.

Static-type information consists of objects provided and maintained by the shared workspace system. Examples of objects are shared workspaces, documents, discussion forums, users, messages, etc. The specific set of objects depends on the given shared workspace system, although in this regard there is usually a large degree of overlap among different shared workspace systems.

Dynamic-type information consists of actions that occur within a shared workspace system. Examples of actions are creating a shared workspace, opening a document for reading, posting a statement to a discussion forum, etc. Actions are performed by action performers: either humans (such as the users of a shared workspace system), or software systems (such as the shared workspace system itself).

For both objects and actions, we distinguish between types and instances. A given shared workspace system typically makes only a limited number of object types available. Users then create (possibly many) object instances of these object types. For example, “document” is an object type. However, a particular document in a shared workspace is an object instance of the “document” object type. The same applies to actions.

A given action may occur in many different contexts. For example, the action of posting a discussion statement could be performed by different subjects (users); act on different objects (discussion forums); be performed in different locations (shared workspaces); and take place at different times. Collections of instances of similar actions can be generalized into a pattern of virtual collaboration.

To give an example: Bob is the user of a shared workspace system. He uses a shared workspace named “Report-Preparation” to collaborate with Alice on the preparation of a report. Bob and Alice use a discussion forum named “Report-Discussion” within this shared workspace to discuss issues related to their joint work. Whenever Bob posts a statement in the discussion forum, this constitutes an instance of an action, namely of the “post statement” action type. The context of this particular action instance may include following pieces of information: the subject “Bob” performing the action, the object “Report-Preparation” (a shared workspace), the location “Report-Preparation” (a shared workspace), and a time (e.g. “1:16 pm, 14/Mar/2004”). The combination of the action type “post statement” with this particular context constitutes a pattern of virtual collaboration, a “post statement” pattern. However, a less specific context, e.g. with a blank value for the time, in combination with the “post statement” action type aggregates all instances of the action type that have the same subject, object and location. Thus it would aggregate all of Bob’s instances of posting a discussion statement to the given discussion forum.

This example is for a quite simple pattern. Below we consider patterns at a larger level of abstraction, corresponding to larger units of collaborative activity. First, however, we introduce a graphical notation we use for representing patterns of virtual collaboration.

2.2.2 EMOO Diagrams

To facilitate communication about patterns of virtual collaboration, we use a graphical notation to represent essential aspects of such patterns. We have extended the MOO notation [18], originally designed for the representation of cooperative business processes, to create the EMOO (extended MOO) diagramming notation for representing patterns of virtual collaboration in shared workspaces. It
uses certain symbols for representing the principal objects and actions involved in virtual collaboration: shared workspaces, users, artefacts, and communication channels. An example of an EMOO diagram for the “post statement” pattern of virtual collaboration given above is shown in Figure 1. In this diagram, users are represented by ovals, discussion forums are represented by hexagons, and actions are represented by arrows. The shared workspace that is the location of this pattern is represented by the surrounding, labeled box.

2.2.3 Levels of Patterns

The example of a pattern of virtual collaboration given earlier captured a unit of relatively small-scale activity. However, collaborative activity in shared workspaces can be of any scale, ranging from minute actions of a single user up to entire work processes involving groups of users. To extend the earlier example of Bob and Alice, these two users are involved in the collaborative preparation of a report. Bob’s “post statement” pattern is only a small part of the larger discussion taking place between Bob and Alice in the discussion forum “Report-Discussion”. In fact, a (possibly large) number of “post statement” and “read statement” patterns (a pattern aggregating actions for reading of discussion statements), originating from both Bob and Alice, together make up a larger-scale pattern of “group discussion”. This is illustrated in the EMOO diagram of Figure 2. The pattern in this figure is thus an aggregation of multiple smaller-scale patterns, including the one of Figure 1.

Such aggregation of patterns can continue onto ever larger scales of activity. As a further example, consider that Bob and Alice’s report preparation work involves, besides discussion of report contents, also the sharing of report documents. An EMOO diagram of a “document sharing” pattern is shown in Figure 3. This figure also introduces another EMOO diagramming notation, namely the artefact, which is represented by a rectangle with rounded corners. In this case, the multiple overlapping artefact symbols represent a multi-artefact, which is a shorthand for representing multiple related artefacts that are treated as one.

Putting the two patterns “group discussion” and “document sharing” together yields the larger-scale pattern of “report preparation” shown in Figure 4. The two original patterns have been merged through their shared users “Bob” and “Alice” appearing in both of them. Patterns can be “plugged together” into larger-scale patterns in this manner if they have one or more objects in common.

Thus a collection of patterns can comprise patterns representing different scale of activity, from the smallest-scale single-user activity to the largest-scale group activity. We refer to patterns of the same scale of activity as belonging to the same level. Patterns of different scales of activity belong to different levels. A number of different levels of patterns were defined in [19]; here we present just three that are most relevant to the current discussion:

1. User level: patterns represent activity performed by a
2. Collaboration level: patterns represent activity performed by two or more users in collaboration with each other, which are aggregations of user-level patterns. For example, a group of users engaged in group discussion.

3. Task level: patterns represent collaborative tasks, which are aggregations of collaboration-level patterns. For example, a group of users engaged in report preparation.

Following this categorization of levels of patterns, the pattern shown in Figure 1 belongs to the user level, the patterns shown in Figure 2 and 3 belong to the collaboration level, whereas the pattern shown in Figure 4 belongs to the task level.

3 Patterns in LiveNet

We used the LiveNet shared workspace system [3] to collect data from which we obtained patterns of virtual collaboration. Our choice of LiveNet is due to two reasons: firstly, we have access to its source code, allowing us to instrument it to collect the data required by us; and secondly, LiveNet is deployed at our university, giving us a ready source of users and data.

LiveNet supports mainly asynchronous collaboration among distributed participants. It provides web-based shared workspaces which bring together people, artefacts, communication channels, awareness facilities, and a collection of tools.

LiveNet is being actively used by several hundred users, students and academic staff, at our university as well as a few other universities. We instrumented the LiveNet system to collect data used for our observations of patterns, both data on instances of objects and actions.

3.1 User-Level Patterns

The data collected by LiveNet provided the base for our observation of patterns of virtual collaboration. This data was very fine-grained, particularly the action data, resembling in its detail the awareness data usually provided in shared workspace systems. We transformed this data into an aggregated and thus more abstract form. We started by listing all user-level action types provided by the LiveNet system, a total of 73 user-level action types. We then mapped the action data we had collected from LiveNet to user-level action instances.

User-level object and action data were stored in a relational database, which we explored through database queries. Among the first things we noticed in our exploration were general usage trends. For instance, we were able to distinguish between two different categories of users: those who were using the system for work, and those who were just “playing around” with it. For members of the former group, we found a significantly larger number of work-oriented patterns, such as creating and opening documents, or posting and reading discussion statements. For members of the latter group, on the other hand, most patterns were related to setting up workspaces, and few were work-oriented. Moreover, in the former group patterns tended be spread out over a longer period of time, whereas in the latter group patterns tended to be much more temporally clustered. That is, groups with more work-oriented patterns actually appeared to be conducting project work through the use of their shared workspaces on a long-term, ongoing basis; whereas groups with predominantly setup-oriented patterns appeared to be mainly experimenting with the system in an initial exploration phase after which they abandoned use of their shared workspaces.

3.1.1 Collaboration-Level Patterns

The user-level patterns discussed above gave us initial impressions of the use of LiveNet workspaces. Next we set out to identify larger-scale patterns, namely collaboration-level patterns which are aggregations of user-level actions.

To identify the set of collaboration-level patterns, we examined which user-level actions connect two or more users. Users can be connected in two different ways: (1) direct connection, where a user-level action performed by one user is directed at another user, such as a user sending a message to another user; and (2) indirect connection, where a user-level action performed by one user affects an object which is subsequently accessed by another user, thus mediating the effect of one user’s actions on the other user. Collections of such user-level actions constitute collaboration-level actions, and thus collaboration-level patterns involving these actions.

In the case of the LiveNet system, there are only two user-level action types that directly connect two users, both of which are related to communication and are used to send a message from one user to another user. The collaboration-level action “Message-Exchange” corresponds to aggregations of these user-level actions for a given pair of users.

Actions indirectly connecting users involve objects accessed by other users. Examining the set of user-level action types, we found three object types involved in these action types: artefacts, discussion forums, and workspaces.

LiveNet has more than a dozen user-level action types that operate on artefacts, performing such functions as uploading, opening, replacing, and deleting. Actions such as uploading, replacing, and opening an artefact all contribute to exchanging artefacts with each other, thus we defined the collaboration-level action “Artefact-Exchange” as an aggregation of these user-level actions. Actions such as deleting, assigning and deassigning artefacts do not directly contribute to the exchange of artefacts. Rather, they are related to managing the set of artefacts available...
within LiveNet. The collaboration-level action “Artefact-Management” aggregates these user-level actions.

For operating on discussion forums, two user-level action types exist, performing functions of posting and opening discussion statements. The collaboration-level action “Group-Discussion” corresponds to the aggregation of all the related user-level actions for posting and opening discussion statements.

Finally, there are a number of user-level actions for configuring the setup of workspaces, such as adding users to a workspace, creating a role, creating a discussion forum, etc. For a given workspace, multiple users may share the responsibility of performing these actions, so an aggregation of these actions may also be considered to be a collaboration-level action, which we label “Workspace-Setup”.

In summary, we defined the following five collaboration-level action types and associated patterns:

1. Artefact-Exchange: two or more users exchanging artefacts.
2. Artefact-Management: two or more users managing the set of artefacts.
3. Group-Discussion: two or more users exchanging discussion statements.
5. Workspace-Setup: two or more users configuring the setup of a workspace.

Each of these action types constitutes a generic type for which specific specializations may be found in actual shared workspaces. For example, details in the configuration of the “Group-Discussion” action type differ depending on how the discussion is used. Figure 5 shows two examples of patterns specializing “Group-Discussion”.

The pattern at the top, “Notice-Board”, is a specialization of “Group-Discussion”, in which one user takes on the role of a “Poster”, i.e. someone posting messages to the discussion forum, which then acts as a notice board. Another user takes on the role of “Reader”, i.e. someone who reads messages posted in the discussion forum. Here, the Poster performs both read and post actions, whereas the Reader performs only read actions. This pattern of interaction of the two different users (or roles) may have been defined in terms of access permissions—only the Poster, but not the Reader, having the permission to post statements. Note that there may well be multiple users acting as Poster and Reader, respectively, without altering the basic characteristics of this pattern.

The pattern at the bottom, “Question-and-Answer-Forum”, is a different specialization of “Group-Discussion” in which one user takes on the role of a “Asker”, i.e. someone asking questions, whereas another user takes on the role of “Answerer”, i.e. someone answering questions asked. The difference between these two roles once again lies in the different set of actions performed by each: the Asker posts statements starting new threads to the discussion forum, whereas the Answerer replies to existing statements, consistent with the question-and-answer type of interaction between the two.

Similarly for other types of collaboration-level patterns, different specializations can be identified. For example, specializations of “Artefact-Exchange” may differ in the way in which artefacts are shared, such as different users (or roles) having different types of access to artefacts, and thus using them differently. Examples of specializations of “Message-Exchange” may exhibit different message-sending patterns: messages either sent unidirectionally (e.g. for notification only), or bi-directionally (e.g. for dialogue); reply messages always originating from one user, or both users replying to each other, etc.

Collectively, patterns at this level offer some degree of insight into the collaborative aspects of the overall virtual collaboration.

4 Conclusions

As we pointed out initially, obtaining observations of collaborative activity is usually a laborious process. We have suggested patterns of virtual collaboration, collected and made available by the shared workspace system itself, as one way forward for more easily obtaining observations of virtual work. Patterns of virtual collaboration may be regarded as work situation descriptions in the sense of Kyng [9] that may be revisited, examined and critically reviewed.
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References