Playing Well with Others: Applying Board Game Design to Tabletop Display Interfaces

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ABSTRACT
Tabletop displays allow users to sit around a shared display in different arrangements. Because there is no single preferred viewing orientation, and because the display is shared by all participants, tabletop displays must be specially developed for effective collaboration. We propose that board games designs can be adapted for tabletop use, allowing the creation of interfaces that are usable by multiple users working on concurrent tasks.

INTRODUCTION
Tabletop displays allow people to sit around a shared display, facilitating group work. One advantage of tabletop displays is their support for face-to-face collaboration: with traditional computer monitors, people must sit shoulder-to-shoulder to view the display. In contrast, tabletop displays allow people to sit in various arrangements, many of which allow people to interact effectively with each other as well as the display. For example, people who sit directly across from one another can see their partner’s facial expressions, which aids their communication.

The flexibility of user arrangements promises more effective collaboration, but it also introduces the necessity to design interfaces for such arrangements. For example, consider the orientation issues that arise when a standard desktop application is displayed on a horizontal surface between two face-to-face users. Only one person will be able to view the display “right side up”, with orientation-dependent items such as text displayed optimally in only one direction. Having to read text upside-down is likely to make collaboration more difficult for a user. Because tabletop displays are fairly new technology, work has only recently begun on how best to design tabletop interfaces in general, let alone how to design for collaborative tabletops. There is, however, a wealth of ideas to borrow from in a related area: board game design.

DESIGN ELEMENTS FOR TABLETOP DISPLAYS

There are many aspects of tabletop displays to which board game designs can be applied. These can be grouped as follows: recognizability of graphical objects under various orientations; accessibility of display for interaction; demarcation of individual and shared space; and creation of public and private display areas.

Recognizability of Graphical Objects
Tabletop displays may contain both text and pictorial items to be read and recognized from multiple angles. Depending on the application, some objects may be rotated to face a particular user (as in the Personal Digital Historian [2]), or multiple copies may be distributed and kept synchronized. However, users may want to use some objects and/or display areas concurrently, in which case the display should be designed to maximize recognizability for multiple orientations. Board games designers achieve this by:

- **Combining Orientations:** Games present text for multiple orientations in three major ways: running text around all sides of the board, orienting multiple sections of the board towards one side, or orienting one section per side. For example, Monopoly uses the approach of running the text around the board: this design ensures that every side of the board has one side right-side up, two perpendicular, and one upside-down. (Similarly, text can be repeated around a smaller area, such as the space designated for playing cards.) These approaches try to reach a compromise for multiple players.

- **Minimizing Use of Strongly-Oriented Objects:** Many boards use icons or other simple pictures in the design. Using icons instead of text can alleviate the problem of having to read text upside-down. Some boards rely heavily on icons, such as Trivial Pursuit (which contains almost no board text). Consideration must be made to ensure that a pictorial item is recognizable from multiple perspectives. For example, regular polygons can be easily recognized from different angles, but human faces cannot.

- **Distinguishing Objects:** Colour can be used to group related objects, which can ameliorate the problem of having to read and/or recognize complex elements. For example, Monopoly uses coloured bands to group related properties: this allows a player to identify related areas quickly without having to read the names on each square.
Similarly, placing objects in a specific area can quickly identify them as having a particular function (or belonging to a specific user). Game boards clearly demark such areas (e.g., by using borders and spacing).

**Accessibility of Display**

Board game players often interact with multiple regions of the game board. There are often shared areas and personal areas: personal areas are placed close to a player, and shared areas generally occupy the middle of the board. This is relevant to tabletop displays in how space is divided: if the display space is superimposed into the input space (as described in [1]), then users may want to touch the display with a stylus. Thus the layout must permit users being to physically reach objects within the shared display regions.

**Individual and Shared Space**

People using a tabletop display should be able to identify which areas are shared, and which are for their own individual use. For example, a user may wish to maintain a copy of a document for their own use while working on a shared document. On game boards, shared and individual areas are distinguished in several ways. Colour is often used, with a player’s token matching the player’s area in colour (such as in Sorry!). Borders are usually sharply drawn as well, with heavy lines and/or additional space clearly demarking individual space. Another category of space is “dead space”, for storage of items that should be accessible, but may be sometimes unused during collaboration. For example, in board games, pieces not currently in play can sometimes be kept on the board corners. For a shared task, there may be transient objects, such as papers (see [1]) that could be placed on the display.

**Public and Private Display areas**

Collaborating users may wish to maintain private space along with the shared display (for example, for keeping private notes). Board games often have private information (e.g., Scrabble tiles, cards) hidden from the view of other players. These private game objects suggest the use of handheld displays for storing private information. (Another possibility might be specialized hardware, such as the filtering glasses suggested in [3].) To keep collaboration flowing smoothly, private information must be well-integrated into the shared display.

**PRELIMINARY PILOT STUDY**

We began our investigations of design elements in a small pilot study that focused on orientation. Specifically, we studied how people collaborate using a tabletop display that is as orientation-neutral as possible, with tasks that are both serial (turn-taking) as well as those with a higher level of concurrency. The tasks chosen for the user study involved two different scenarios: a map-based task, and a photo-matching task. Both displays were composed of paper prototypes that were mounted on a rotating base. First, users were given a large map of Europe with many cities on it; this was oriented in only one direction. Participants were asked to find 12 cities on this map, in two separate tasks (one concurrent, the other turn-taking). The photo-matching scenario used a layout that was more orientation-independent than the map. Twelve photos were presented on the display, with 3 photos in each of 4 orientations (such that 3 would face each participant, and 6 would be sideways to both). Participants were given a sheet of 24 photos, and had to match 12 of these with the 12 display photos. Again, one photo task was concurrent, and the other serial. The pilot study was conducted with two pairs of users. Each participant was shown how the display rotated, and was told that they could rotate it at any time.

**Results of Preliminary Pilot Study**

This initial study was intended to address any problems with the preliminary experimental design. With such a small study, results cannot be generalized, but there were some interesting findings. First, people do not rotate the display very often, preferring to use the display as presented (either compensating by reading upside down or using a display that is less orientation-dependent). Second, rotation is more likely to occur when the task is serial. People are reluctant to move a display when they feel it will inconvenience their partner. Thus, adjusting a display may have negative implications for collaborative work.

The next step is to investigate collaborative tasks that would translate well to actual uses for tabletop displays, and test alternative layouts for these. The next stage of testing might move away from the paper prototype to a computerized display. We will also look at additional design aspects (e.g., distinguishability of objects). These could be added to the layout fairly easily without overcomplicating the testing process.

**CONCLUSIONS**

This early pilot study suggests that rotating a display is not desirable for tasks performed concurrently, and may not be optimal even for tasks performed serially. A major open question that remains is whether one solution—re-designing layouts to be more orientation-independent—is truly an effective approach. In order to test this hypothesis, a new set of tasks must be derived that are representative of real-world collaborative work. Furthermore, the displays for these tasks must be chosen so that there can be a means of comparison between different design approaches used for tabletop interfaces.

**REFERENCES**

