

# Scheduling with Pin&Play: Augmented Pushpins as Support for Large-Scale Collaboration

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## Abstract

*We have developed a prototype that investigates how paper-based collaborative scheduling practices can be supported with computation. Our design is based on fieldwork conducted during the preparation of a film festival and is implemented with Pin&Play, a surface-based networking technology with interactive pushpins. In this paper we describe the fieldwork, the resulting prototype and findings from its evaluation with the festival organisers.*

## 1. Introduction

Even though paper lacks many advantages of digital media, it has properties that often make it preferable to digital solutions. For example, paper is flexible and quick to work with. Studies of collaborative work practices have showed how large surfaces in combination with paper give users control and overview of information (Bellotti and Rogers 1997, Perry and O'Hara 2003). How can we support such work practices and keep the physical benefits of paper or other low-tech material, while adding digital advantages?

In order to explore this question, we have studied work practice at the Göteborg Film Festival, where the team uses paper notes on large surfaces to schedule the entire film programme. Using their case as an example, we have built a small-scale prototype based on ubiquitous computing technology that illustrates how the team could continue using paper notes on notice boards while gaining advantages of computation. A number of ubiquitous computing technologies are currently in development that potentially could be adapted to support local collaboration, such as large displays, gestural interfaces, etc. We have used a novel technology called Pin&Play that consists of computationally augmented pushpins and large networking surfaces (see Figure 1).



**Figure 1. Pin&Play pin (left) Collaborative scheduling at the Göteborg Film Festival (right)**

In the following, we will first introduce the work practice at the film festival and the prototype illustrating computational support. Thereafter we will report what we learned from evaluating the prototype with members from the film festival team and draw general conclusions from the results.

## 2. The Göteborg Film Festival

The film festival uses entire walls as notice boards with paper notes representing films, in order to schedule their annual event (see Figure 1). This is a highly collaborative process that results in a film programme of about 700 films.

We conducted observations and several interviews during the planning of two consecutive festivals. The first year's session of fieldwork gave us a general insight into and an understanding of the activities, which lead to preliminary implications for design (Håkansson et al. 2003). During the second year's session, which is reported here, we focused on understanding the entire process in greater detail. This allowed us to draw more specific and concrete implications for the prototype that now has been implemented and evaluated.

## 2.1 Fieldwork

We conducted fieldwork during the scheduling of two consecutive festivals. The number of team members who were active in the scheduling varied from two to five during the observation sessions, but always included the manager. During the first festival planning, two observations were conducted during intense scheduling activities, each lasting for approximately three hours. During this time, we observed the team and took notes without asking any questions. Occasionally the festival crew gave us spontaneous explanations about their activities during the process. Interviews were carried out both before and after our observations of the actual scheduling process. One was held with the film festival manager, the person who is in charge of and also an active participant in the scheduling process. Another was held with the team member in charge of the current database system. For the second festival planning, only one observation was conducted, lasting about two hours. This session was also videotaped and complemented with interviews.

## 2.2 Scheduling the Festival

The observations and interviews gave us a considerable understanding of the team's work process and their specific use of large work surfaces, paper notes and current computer support.

The festival takes place over 10 days every year, and shows approximately 700 films. During a festival the number of employees can reach 200 people, but the rest of the year five people are employed full-time. They are also the ones who handle the majority of the actual scheduling. Overall, the festival work can be viewed as five different activities:

- Research about what films should be shown
- Schedule preparation, adding needed information for each film
- Scheduling
- Schedule-check and transfer to database
- Practical use of the schedule: catalogue making, web site etc

The research starts at the end of the previous festival. The programme group travels to different international festivals collecting information, enters possible films in a database, and eventually invites selected films to the festival. As films in the list get accepted, additional information is added to the database and the schedule preparation can start. This first involves writing physical paper notes representing the screenings for each film, with basic information (title, format and length). There are usually three notes

for each film, which corresponds to the number of screenings. A paper note can also represent a "set" of short films that will be viewed at the same screening. There are approximately 700 paper notes in total, corresponding to the number of screenings. Each note has a specific colour, depending on which category the film represents, such as country of origin or other themes. The preparation also includes blocking certain times in the schedule, for example to show that a cinema is not available at certain hours.

During the planning, the schedule is built by pinning the notes representing films to large boards, covering two entire walls. The boards have a number of "slots" arranged in a matrix. On the boards, each of the 14 festival cinemas is represented by a column, and each of the 8 screening times by a row. Every day of the festival has a separate matrix, meaning there are 10 groups in total, with 112 slots each. Therefore, by physically pinning a paper note to a specific position in this very large matrix, the corresponding film is scheduled to be screened at a certain cinema, during a certain time on a certain day.

This is a highly collaborative process, simultaneously conducted by at least two persons. The team has to handle a lot of information, which creates a heavy cognitive load. They take advantage of their previous experience of festivals, as well as their own research about the films. They use tacit "fingertip" knowledge to determine the screenings that are suitable for a film. This includes expected audience, subjective feeling, and current and expected publicity for the film in question. Other kinds of information are of a more practical nature. For example, this can be film format, length, availability, transport time between screenings, award screenings, seminars, school screenings, director visits and so on. On top of this, sudden changes happen, for example a cancelled invited speaker, new films that are accepted, or others dropped from the programme. Most films are already prepared as paper notes before they are scheduled. However, it does occur that a slot is booked "on the fly" by a spontaneously created Post-it note or other piece of paper, temporarily representing a film or an unavailable screening time.

Other people also need access to the schedule, for example a group that works with arranging seminars in a separate room. They use another board with related seminar information, located in their own room. If a film with a related seminar has to change screening time, the seminar arrangements will have to follow the film. This sometimes creates problems since the seminar group cannot see the main boards from their physical location.

When the physical schedule is considered to be ready, it is proofread several times before a screening

number is written on each note. After this, the schedule is transferred to digital format. One person starts reading in one corner of the board, consecutively dictating each number and film, while another enters this data into a database. When this is done, the final screening database is compared several times with the physical schedule. This screening database is then the basis to a SQL server, which is used in ticket vending at the cinemas and on the homepage. The finished schedule database is also used in the making of the festival catalogue.

The work practice at the film festival has been essentially the same for over 20 years. The team stresses that they need the large boards for overview and collaboration, claiming that an entirely desktop-based solution would not be workable. The current process with paper notes provides a flexible work practice, where it is fast and easy to make changes. It also gives them many opportunities to improvise and create new functions. For instance, notes are sometimes positioned somewhat askew, which represents a scheduling that has not yet been fully decided. Furthermore, the colour-based system for categorising different films gives them support in gaining overview of the schedule as it is created.

However, this working procedure presents several difficulties. As mentioned, the team members currently have a heavy cognitive workload. Information on paper notes can be incomplete and there is a risk of getting the manually calculated end time of a screening wrong. Currently, the schedule has to be constantly checked manually for possible errors. Potential errors include that there is not enough time for transportation between cinemas, or that a screening is not synchronised with a guest, that the film's format is wrong for the cinema, and so on. If the information that the team members have to keep in their heads could be reduced, errors could probably be minimised. Another problem that becomes increasingly important as the schedule grows is to locate a specific film on the board among hundreds of other notes; often this can take up to fifteen minutes.

Finally, when all 700 notes are up, the schedule needs to be manually transcribed. Not only does this require a lot of work, but there is also a risk of transferring the wrong details from the schedule to the ticket database and then on to the programme brochure, which, in the words of the manager, would be "a disaster".

### **3. Supporting Large-Scale Collaboration**

Several technologies have been developed to support large-scale group collaboration. One approach

is to use large touch-sensitive displays (e.g. Streitz et al. 1999, Johanson et al. 2002), where on-screen digital information replaces the physical artefacts, and users manipulate information directly on the screen. A drawback with such technology is that large screens are still quite expensive and have limitations in size, making them inappropriate when users need very large augmented surfaces. The resolution of these large screens is another critical issue when the information shown needs to be very detailed. For instance, today's large screens can still not provide enough details when displaying the same information as a large number of handwritten Post-It notes. Furthermore, this approach neglects the inherent physical benefits of paper and other physical artefacts.

Another solution is to provide interfaces that support the manipulation of physical objects connected to electronic information and events. Computer vision technology can be used to identify physical objects and their movements, possibly in combination with a projector to augment them with digital information. Two examples of such system are The Designers' Outpost (Klemmer et al. 2001) and Collaborage (Moran et al. 1999). However, technical limitations such as camera angles and light conditions constrain users to use and benefit from such systems. The size of the surface is also dependent on the number of cameras used, as one camera only covers a limited area.

Yet another solution is to have a tag reader incorporated in the surface. For instance, Senseboard (Jacob et al. 2002) used physical tokens with electronic ID tags that could be attached to a board. A data projector overlaid the physical tokens with digital information. Users could manipulate digital data by moving the tokens on the board. A drawback was that the system did not allow for paper notes or other everyday objects, and requires special RF-ID tagged pucks.

#### **3.1 The Pin&Play Technology**

Pin&Play (Laerhoven et al, 2003) makes it possible to combine physical and digital information on large surfaces. Pin&Play provides digital augmentation to objects that are commonly attached to surfaces, such as pushpins. The technology consists of interactive and networking pushpins, which allow familiar interaction of pinning notes. A conductive surface serves as a physical medium for both communication and power. The interactive pushpins are independent entities that can communicate and store information. Pin&Play can turn an entire wall into a network where users can post notes that are aware of each other's content.

As opposed to the solutions mentioned above, where digital information is projected on physical

notes or objects, the Pin&Play interactive pushpins store their digital information themselves. The conductive surface is cheap, flexible, can take any appearance and supports large-scale networks. It is also possible to connect several augmented walls or surfaces into a larger network.

Pin&Play is one among several projects that focus on turning a physical surface into a network. Most closely related is Pushpin Computing, a technology using a similar infrastructure to Pin&Play, where pushpins are attached to a layered conductive sheet (Lifton and Paradiso 2002). In another approach, the Networked Surfaces project at Cambridge (Scott et al. 2002) focuses on horizontal surfaces.

#### 4. The Scheduling Prototype

The prototype was developed to support the team's current paper-based work practice and provide constant digital support. Before starting to build it, we gathered members from the festival team to discuss preliminary design implications for a prototype using the Pin&Play technology. The team also provided us with additional feedback throughout the design process. A full-scale prototype would not have been feasible at this point, so we decided to build a small-scale version that still could illustrate realistic limitations and possibilities scheduling support.

The prototype was created with 15 screening slots, distributed over two days, with three start times and three cinemas. It was implemented so that each paper-note, representing a film, is attached to a smart pin. When this combination is pinned in a slot on the board, it represents a film screening. The screenings are both represented physically on the board, and digitally on the web interface that also provides additional information (see Figure 2). A web interface is connected to a database, which is constantly polling the current state of the board. For additional technical details about the prototype, see Helin et al. (2004).

It was important to create an association between a pin and a film note, without adding extra work for the team. Therefore, we decided to hard-code the digital association between the film and pin, and discussed possible implementations in the evaluation with the team.

Based on the fieldwork and the design implications, we defined detailed actions that the prototype should support. Below are four crucial actions that exemplify how users interact with the system:

**Scheduling a film:** The user schedules a film by pinning it to a slot (with a specific time, cinema and date). The pin is identified and located and if the film is not suitable for the selected time slot (e.g. the film is



**Figure 2. Scheduling prototype board with Pin&Play pins and paper notes representing films (left) Web interface showing the state of the board (right)**

too long, or its format is not supported at the chosen cinema) the user is notified with icons and more information on the web interface. By pinning additional films to the same slot, several films (e.g. short films) can be scheduled for one screening.

**Searching for films with certain criteria:** The user can search on the web interface, to more easily find films corresponding to a certain criteria (e.g. title, director, genre section, format) on the physical board. The LEDs on the pins of the matching films will light up, making them easy to locate on the board. This provides the user with an overview of the result in a larger spatial context, with complementing results on the web interface.

**Displaying additional information about a film:** When the user needs to find more information about a specific film, he or she can attach a query pin to the same slot as the film occupies. The query pin's presence triggers the web interface to display all additional information about the film and its screening.

**Transferring the final schedule to the database:** When the scheduling is considered finished, it can be automatically transferred to a database. The system calculates the end time of every film and gives each film a unique screening number. If several films (e.g. a short film and a feature movie) are placed in the same slot, they get the same screening number (to be treated as one unit in the film programme). The web application then displays an updated schedule with screening numbers. The user can check the schedule before exporting it to the database.

In case of a system breakdown, an implementation with Pin&Play would allow the team to continue their physical scheduling as usual. When the system is recovered again, it can automatically pull information from the board to update the digital schedule.

## 5. Prototype Evaluation

Two members of the festival team, the overall manager and the technical manager, took part in the evaluation. The session lasted for about two hours (out of which the actual test took one hour) and was conducted at our lab. The prototype and its functions were briefly explained, before the participants started to conduct tasks, including: scheduling a film, re-scheduling a film, finding detailed information about a film (by using the query pin), searching for films and locate the resulting ones on the board, giving all films screening numbers, and finally exporting the final schedule to the database. The tasks were chosen to reflect their current work practice and also to bring out as much functionality as possible from the prototype. By constraining the tasks, we felt that it would be easier for the team to understand the functionality, and make them reflect on how well their work practice had been captured in the prototype. The intention was that having the two team members working together would lead to a broader discussion about the prototype. This approach also reflected the way they are used to collaborate during the actual scheduling. We encouraged them to think aloud while conducting the tasks, and after the test a discussion was held.

### 5.1 Results

The festival members expressed that we had succeeded in capturing their work practice in the prototype, while facilitating its procedure, and lowering their potential workload. The prototype seemed to provide a good support for many of the critical tasks in the scheduling process, and raised several considerations for how to support collaborative paper-based practices.

The team members appreciated the fact that films had the same colour on the board as on the web interface, which provided a direct visual association between the physical and the digital representation.

The festival team found the notification icons to be an excellent function that would make it easier to avoid mistakes, since they immediately show if a film is unsuitable at a certain slot. They even suggested that it would be possible to show more icons, representing events and so on. However, they expressed a concern about having too many icons because it could make the important ones less visible.

In the current prototype, notification icons about the suitability of a film's placement are shown on the web interface. The festival team expressed a need for direct feedback on the physical board, when placing a film.

This could be solved by making the LED on the pin blink, when the chosen screening is unsuitable.

The team found it useful to be able to search on the web interface for films with a certain criteria, and view the results both on the physical board and on the screen. They also commented that even more items could be included in the search function. For example, searching for different types of notification icons would be a way of checking the schedule for possible errors, or searching for other genres beyond the ones currently represented by the paper colours. The users also found it important to be able to easily count their searches, which could be solved with a "number of hits" display in the search function.

Displaying additional information about a film by attaching the query pin to an occupied slot was considered a less successful feature. The team thought that it was not important to start a search at the board, and that it would be simpler to just type directly on the web interface.

When scheduling a film, the system sometimes took several seconds to represent an attached paper note on the web interface. This was caused by our positioning solution based on slots, a quick and simple solution for a prototype not intended to be part of a real implementation. The participants seemed to accept this limitation as a prototyping issue that would be improved with a different positioning solution.

Transferring the schedule to the database was considered by far the most important function of the prototype. The team claimed that this in itself would save them two days of work, which is extremely valuable time before the start of a festival.

We discussed possible solutions for a future system that would not need to hard code pins with paper-notes. The users suggested that a "docking station" would be a good way to connect a pin and a film. This would almost not require any additional work for them, and could be performed in the preparation phase, when information in the computer database is used to create notes.

The web interface makes it possible for people not located in the same room to follow the scheduling. The team suggested that other parallel scheduling activities (such as seminars) could be synchronised with the film scheduling. This would simplify the overall film scheduling, including for those in charge of inviting speakers.

A full-scale implementation would need more robust pins and a softer insulation material. The current pins were experienced as somewhat fragile and the chosen insulation material was a bit hard to pin through. In combination with the latency of the system, this made users uncertain about whether they had successfully attached a pin to the system (and thereby

connected to the network). The team were also concerned about being able to see the LEDs in a bright room, indicating that stronger lights or other notification channels could be useful.

## 6. Conclusions

We have created a prototype to investigate computational support for paper-based collaborative scheduling at a film festival. The prototype is based on Pin&Play technology, and illustrates general possibilities and challenges for supporting paper-based scheduling practices.

The main challenge for the prototype was to maintain a consistent link between the physical and the digital representation. The flexibility of paper is kept in our prototype. The team can still use an informal coding system (e.g. positioning a note askew to inform that there is something to consider with that screening).

While some representations are more suitable in a physical form (e.g. queries that require spatial overview), some are better managed in a digital form: such as a typed-in request for more information about a film.

Our prototype illustrates how collaborative scheduling work can benefit from computational support, and still allow paper-based practices. We believe that there are several benefits with such support, even if it introduces challenging issues both technological and representational.

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