Floor Interaction

HCI Reaching New Ground

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ABSTRACT
Within architecture, there is a long tradition of careful design of floors. The design has been concerned with both decorating floors and designing floors to carry information. Ubiquitous computing technology offers new opportunities for designing interactive floors. This paper presents three different interactive floor concepts. Through an urban perspective it draws upon the experiences of floors in architecture, and provides a set of design issues for designing interactive floors.

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HCI REACHING NEW GROUND

What are the challenges and design issues of designing interactive floors, i.e. interactive surfaces embedded in the physical environment, which are controlled by several co-located people?

Rodden and Benford [8] draw upon research in architecture when they point to new directions for ubiquitous computing, and indeed, this tradition has a lot to offer when we seek to understand the role of floors and potentially interactive floors. Rodden and Benford [ibid] further the criticism that much research in ubiquitous computing has focused on 'stuff' and has not yet explored how ubiquitous computing can be realized on higher levels of 'space plan'. Interactive floors are an example of a focus on a higher level of space plan.

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In this paper we discuss how architectural knowledge, as it has been used in three concrete prototypes of interactive floors, can provide a basis for design. Furthermore we discuss how new interaction paradigms are challenged and informed by an architectural approach to interactive floors.

INTERACTING WITH FLOORS

Understanding human computer interaction, when computation is embedded in interactive floors is yet an unexplored topic. However, a few design concepts have emerged, which point to the potential of this area. For instance in the area of game design, interactive floors have been used as means of controlling games [4]. Also a couple of interactive dance floors have emerged [2]. Thus current applications fall primarily in the area of gaming. There are also a couple of examples of the exploration of the technical side of interactive floors. E.g. camera tracking facilities have been developed allowing for tracking of peoples' movement of floors [5]. Furthermore, Georgia Tech has developed the smart floor concept allowing for seamless identification of users based on the pressure profile of their footsteps [6]. These technological possibilities are yet to be fully explored in design concepts and applications.

In the following, we wish to point out that interactive floors have a much richer potential than what current applications suggests. A way to pursue this is to understand some of the general qualities of interactive floors. Here the tradition of architecture is a good resource.

FLOORS IN ARCHITECTURE

Floors seen in a broad architectural frame can be understood as either streets or plazas [9]. To unfold the meaning of this we look to the classic European city where streets lead pedestrians in a direction whereas plazas exist as junctions between intersecting streets. The distinction between street and plaza lays in the controlled framing of the space. Street understood as floor is a surface that holds a certain direction which supports the understanding and perception of the space from a certain point of view,

whereas the plaza is the floor where there is no perfect viewpoint and where the perception evolves as the pedestrian explores the space. This framing of floors can be transferred to interiors as well pointing at corridors and junctions of these e.g. a living room. The social impact of these two understandings of floors are not related to private/public but rather to the individual or shared perspective of the surrounding space that street and plaza enables. In the street the pedestrians stroll in a certain direction whereas the plaza supports multiple walk patterns. Over the centuries changes in artistic and stylistic paradigms has experimented with directing peoples' attention and traffic movements in both subtle and more outspoken ways. Throughout history floors either as streets or plazas has been an important architectural element both in terms of decoration, conveying information, regulating use and creating aesthetic and architectural coherence between collocated elements and buildings. To illustrate this two works of classic architecture is used.

In medieval churches and cathedrals the floor functioned as a decorative symbolic guidance as well as an information surface. In the Chartres Cathedral near Paris, France an eleven-circuit labyrinth divided into four quadrants is depicted on the floor. See figure 1, left. A part from being a decorative element, the floor serves symbolic acts of repentance as well as pilgrimage. At other sites such as Piazza del Campo Siena changes in the pavement is used to symbolize Siena's then ruling body, the Council of Nine, their power and the nine folds of the Madonna's cloak. See figure 1, right. Furthermore, del Campo is not owned by any of the 17 "contrada" of Siena which is why the plaza is the preferred place for any public events, ranging from the famous Palio to everyday marketplace activities.

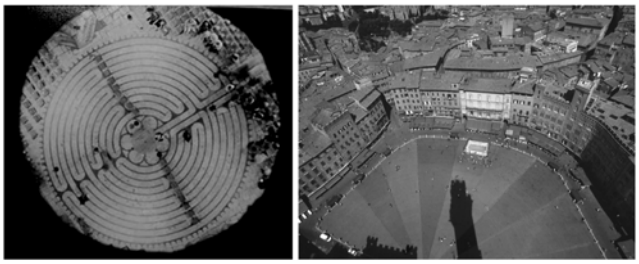

Figure 1 Labyrinth in Chartres Cathedral on the left, and Plazza del Campo on the right

From a design perspective one can take advantage of many subtle signs in defining areas and accessibilities on floors e.g. changes in colour, material and light. However, the main characteristic of a floor is the fact that it is equally shared by all of us.

From an architectural point of view interactive floors address a range of problems such as a high degree of flexibility, which is currently not supported in building components etc. With an interactive floor, surface styles, applications, and interface, can be changed based on who currently visit or rent the facility. In terms of designing applications for interactive floors, this implies that such installations in public space are especially suited for drop-by interaction and that interactive floors support several users cooperating and having a shared experience of a space. Interactive floors however, demands means for interacting with the material displayed on the floor.

THREE INTERACTIVE FLOOR CONCEPTS

In the following, we present three different interactive floors, which are results of our work in the research center of InteractiveSpaces. The three design concepts have different forms ranging from a vision prototype, a running prototype, to a full implementation, which has been tried out in a library setting over a period of two weeks. Thus although these design concepts have very different status, in the following, we discuss them on an equal basis, as they represent very different solutions to floor interaction, and thus provide a good basis for reflecting on challenges and possibilities around this.

Playful interaction

Playful interaction (See Figure 2, left) is a vision prototype developed as part of the Workspace project [1]. The motive behind the vision was to explore how more playful relations to materials can be established in a work environment. Among other ideas, this video depicts a vision where digital materials can be placed on- and picked up from a floor through bouncing a ball on the floor. Thus the ball is used as a means for placing and picking up documents on physical surfaces like floors and walls. Documents are organised in dynamic tree structures, oriented primarily one way. People stand on the surface when interacting with it.

Figure 2 Playful interaction on the left, and iFloor on the right

While other aspects of the video prototype have been implemented, the ball itself is not yet implemented due to technical challenges.

iFloor

iFloor (See Figure 2, right) is a concept for multi-user interaction around a digital floor in a library context [3]. The motive behind the concept is to create an attraction of the physical place of the library, in a time where more and more materials can be distributed from the library remotely. The concept is implemented in the form of a running prototype, and this experimental prototype has been set up at a municipal library for a period of three weeks.

The floor allows visitors in the library to post questions and send answers to each other. The Q/A's are displayed around on the floor, in a circular array such that they are equally well accessed from all directions. There is no dominant direction. Visitors browse them by means of a cursor. There is one shared cursor on the floor, which visitors through their body movements drag around on the floor. It is easier to control the cursor, when more than one person interacts with the floor, and the playful challenge consists in coordinating and negotiating movements to pull the cursor to the intended spot on the floor.

MediaSurfaces

MediaSurfaces is a concept allowing people to distribute their digital materials on a range of connected interactive surfaces in the home [7]. These surfaces range from being table projection, wall displays as well as projections on floors. Floor projections are oriented in one direction, e.g. such that the materials are displayed at the entrance and viewed as people come home.

Figure 3 From left to right: close-up of table. Emote, and mediafloor.

The concept draws upon various studies of how people handle physical materials in their homes, which also points to examples where placing e.g. paper mail on the floor at a specific spot in the home is a way of attaching status to the mail. The means of interacting with the digital floor display is through a gesture-based remote control. The remote allows users to control the materials displayed on the floor, e.g. flicking through pictures displayed on the floor. This concept is developed in the form of a prototype, which will be put out in a home for a two week period of testing.

DESIGN ISSUES FOR INTERACTIVE FLOORS

The three different cases point to the range of different application areas of interactive floors, beyond the prevailing focus on games. The concepts presented in this paper address such diverse domains as the workplace (Playful interaction), public space in libraries (iFloor), as well as private homes (MediaSurfaces) and thus suggests that the full potential of interactive floors are yet to be explored. Using the distinction of street and plaza derived from urban planning research in understanding and characterising the use situation of an interactive floor allow us to bring forward a set of design issues for such installations. The perspective points to a richer use of such floors than we have seen up till now. The architectural approach implies the notion of scale and orientation and alternative positions, which in the three cases goes beyond the common screen display requiring new interaction paradigms.

The urban perspective on interactive floors also involves regarding technology as an integral part of the public environment implying that it should cope with filth and rough use as any other public design. In the case of the iFloor this is done by using technologies that slip into ceilings leaving only tracked projected footprint on the floor - street or plaza. Such setup introduces the notion of dirty computing where the interface is not treated as something precious and fragile but rather blurs into the environment through muddy footprints and spots from soft-ice, and is thus adapted into the fabric of everyday life (See Figure 4).

Figure 4 The iFloor – mud and technology go together

Apart from the three cases' ability to cope with dirty computing they relate, as mentioned earlier, differently to the architectural arc types of street and plaza. Viewing the three design concepts through these perspectives help describe and understand the different nature of the concepts, e.g. their social impacts and interaction styles. The three cases will now be discussed in relation to these issues.

Interactive floors as Plaza

Interactive floors as plaza hold the following characteristics. It supports drop-by interaction and provides multidirectional access to materials. Playful interaction and iFloor resembles the plaza more than the street, in that they support people in meeting casually, on the fly, and provide multidirectional access and interaction as well as equal points of view.

As a shared surface between users, interactive floors as plaza hold opportunities for creating truly shared interfaces. Especially the concepts of iFloor and Playful interaction utilize this opportunity. iFloor being placed in the central space of the library, a public place with a public task of being open to any citizen, it needs to be egalitarian and accessible. This is supported through the walk-up and use interface providing equal and collective access for all library visitors.

Interactive floor as plaza is a shared interface supporting shared focus of attention – right up to the point in time when other people around the floor becomes more

interesting. Then the interactive surface moves into the background and the interaction between people will step into foreground. This happens in Playful Interaction where a playful approach to knowledge sharing in the office environment is proposed in terms of picking up documents and transferring them to colleagues through bouncing a ball in the floor and throwing it to a colleague. This is in opposition to a more rigid notion of a productive and functional office environment.

Interactive floors as Street

The nature of interactive floors as streets is characterised by designing to support individual strolling through providing directed routes, prepared for unidirectional access, and more efficient interaction as compared to what the Plaza represents. The concept of MediaSurfaces holds more the characteristics of the street than the plaza in that it assumes certain directionality in the access to materials. It supports the unidirectional access to materials as they are experienced as people stroll by a floor display. But MediaSurfaces, with the gesture-based remote control, explores more playful ways of interacting with the materials displayed on the floor than the Street arch type suggests.

Design issues for Interactive floors	**Plaza**	**Street**
Nature of interaction	Drop-by interaction	Directed route
Directions of access	Multidirectional access	Unidirectional access
Interaction ideals	Playful interaction	Efficient interaction
Social/individual	Social interaction	Individual strolling

Table 1 Design issues for interactive floors as Plazas and as Streets

While street and plaza are useful for analyzing concepts, they may also be used more generatively, as design parameters, or as a way to broaden up the design space. As summarized in table 1, they raise rather different design issues.

CONCLUSION

We have unfold the challenges and design issues of designing interactive floors through pointing to the distinction between plaza and street. We have suggested that they are useful categories to consider when designing interactive floors. As characterised here, they can be seen as endpoints of a spectrum. Many concepts will be blends of these. However, the arch types illustrate the challenge of giving these different characteristics a concrete form in interactive floor concepts. A challenge, which we have just started to take up with the interactive floor concepts presented in this paper.

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