Remarkable Objects: Supporting Collaboration in a Creative Environment

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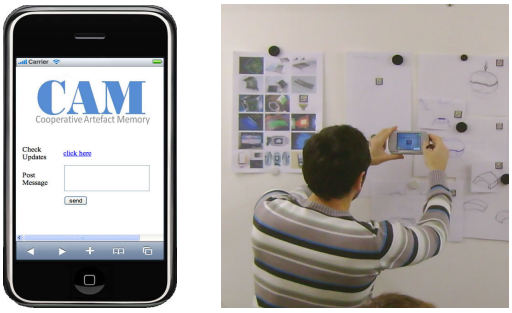
ABSTRACT
In this paper, we report the results of a field trial of a Ubicomp system called CAM that is aimed at supporting and enhancing collaboration in a design studio environment. CAM uses a mobile-tagging application which allows designers to collaboratively store relevant information onto their physical design objects in the form of messages, annotations and external web links. The purpose of our field trial was to explore the role of augmented objects in supporting and enhancing creative work. Our results show that CAM was used not only to support participants' mutual awareness and coordination but also to facilitate designers in appropriating their augmented design objects to be explorative, extendable and playful, supporting creative aspects of design work. In general, our results show how CAM transformed static design objects into 'remarkable' objects that made the creative and playful side of cooperative design visible.

Author Keywords
CAM, Awareness, Cooperative Design

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms
Design, Human Factors

INTRODUCTION
Physical design objects such as sketches, drawings, storyboards and 3D models play an important role in supporting collaboration in the design studio culture [6, 11]. Collaboration in design studios involves, among other things, conveying tacit, aesthetic and inspirational aspects of design problems. In this case, the material and experiential qualities of physical design objects greatly support these aspects [7, 16]. Several attempts [1, 2, 8] have been made to computationally augment these design objects to enrich collaboration in design studios. We have developed a mobile-tagging based application called Cooperative Artefact Memory (CAM) that allows designers to collaboratively store and access relevant information onto their design objects (Figure 1). CAM uses 2D barcodes to identify design objects, and a mobile phone to capture and access descriptions around these objects. CAM falls into the category of awareness system [e.g. 9], as it allows designers to asynchronously support and maintain awareness about ongoing design activities through design objects. The design of CAM is based on the results of a longitudinal ethnographic field study [14, 15, 16] in professional and academic design studios. These results, in brief, emphasized the importance of material design objects and the use of studio space in supporting social and explorative flexibility in designers' work.



(a) (b)

Figure 1: (a) CAM running on an iPhone; (b) Reading a design sketch using Microsoft's TagReader client.

In this paper, we report the results of a three week long field trial of CAM in a Product Design studio. The purpose of this trial was not to evaluate CAM as a fully-fledged technology, but to 'probe' the role of augmented design objects for supporting cooperative design and creative work. Our field trial results indicate that our participants appropriated physical design objects not only to support mutual awareness and coordination, but also to support creative and subtle design activities. From the results of our field trial we characterize these 'remarkable' design objects as cooperative, aware, explorative, extendable, and playful. In general, our contribution in this paper is twofold. 1) We show how CAM enables *new* possibilities for design teams for supporting creative aspects of their design process. 2) Our results contribute towards the 'call' to broaden Weiser's vision [17] on UbiComp by bringing social and cultural values to the design space [4, 10].

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CAM (Cooperative Artefact Memory)

CAM (Figure 1) is a simple, low-tech system that combines off-the-shelf tools such as Microsoft's mobile-tagging application TagReader, 2D barcodes and a JAVA web server that uses Twitter API. CAM allows designers to cooperatively store relevant information onto their physical design objects (such as sketches, collages, physical mock-ups) in the form of written messages, annotations and external web links. Using CAM, design objects can have an individual digital profile on the Internet where relevant information can be added, updated or changed by all designers. The central idea in CAM is that it associates each 2D barcode to a Twitter account. Hence, when one reads a 2D barcode attached to a design sketch (Figure 1b), for example, one can read a set of messages about the object in the Twitter interface. CAM has a very simple interface (Figure 1a): "Check Updates" allows viewing of all the messages of a design object and "Post Message" allows designers to write and send a new message to it.

In the rest of the paper, we first describe the probing approach used in our field trial and then we describe our results focusing on the role physical objects played in supporting creative design.

FIELD TRIAL – PROBING CAM

In a Product Design studio, we probed the use of CAM over three weeks. We asked three student design teams to use CAM for their one week long design projects. The students were paid twenty Euros for their participation and it was made clear to them that our field trial had no implications on their grading. Table 1 shows the details about our participants and their design projects.

Design Team #	Educational Year	Design Projects	Number of Participants
1	1st Year	Remote Control	4
2	3rd Year	Alarm Clock	4
3	5th Year	Intelligent Lamp	4

Table 1: Details of participants

For the trial, we gave each of the participants a camera-based smart phone. We also gave them a set of 2D barcodes generated from Microsoft Tag, and created several temporary Twitter IDs. They were first given a demonstration about how CAM works and how they could send and receive messages. They were asked to use CAM during their project as a tool to store information onto the design objects. Since our intention was to use CAM as an explorative tool to learn what role design objects could play in supporting creative work, we completely left it to the design teams to use CAM in their preferred ways. We also encouraged them to use the Wi-Fi from the mobile phones.

We videotaped their design sessions throughout the course of the projects, and we interviewed all team members at the end of each session. Additionally, we used an awareness questionnaire, adapted from the ABC (Affective Benefits in Communication) questionnaire [13], to understand how CAM changes designers' perceptions about their work-place awareness. Our questionnaire had a seven-point Likert scale and consisted of 10 questions, and was used both before and after the use of CAM. The use of Microsoft's TagReader application allowed us to collect the usage logs of the 2D barcodes. We also analyzed the messages of design objects from their Twitter logs.

RESULTS – REMARKABLE OBJECTS

We observed that our participants easily incorporated CAM into their everyday design work. Between the three teams, a total of 53 design objects were tagged with 2D barcodes, 197 messages were sent to these objects and these were read 488 times in total. The team-wise distribution is presented in Figure 2. Our analysis included interview and questionnaire results, logs of the 2D barcodes, the tagged design objects and their Tweet messages. In the following, we describe the 'remarkable' nature of design objects that played an important role in supporting creative design.

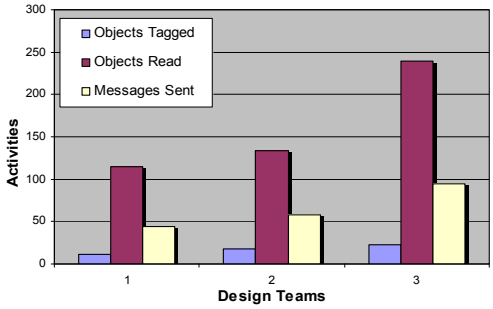

Figure 2: Team-wise usage of CAM over three weeks.

Cooperative

CAM facilitated design objects to support cooperation between designers. Using CAM, participants recorded design ideas, activities, important decisions and milestones onto their design objects. We observed that after participants had described their design objects, co-workers made comments, suggestions and asked for more clarification about certain issues. On some occasions, open questions were asked to invite discussion, and on others, confirmation of certain design activities and important decisions were recorded. Figure 3 shows a foam model of an alarm clock (team 2) and its Tweet log (in German). One can read information pertaining to the design model,

Figure 3: Foam model of an alarm clock with 2D barcode and its Tweet log showing different activities.

cautious remarks, and design suggestions made by colleagues. In this way the design object created a kind of a dialogue between designers. Here is a comment made by a participant during an interview: "*The useful thing about CAM is the new ideas that we get from others. I found this very stimulating for my creativity. For example, Max had this function of pushing in the alarm clock and I had a separate switch. From Max's design and my design we merged the interesting ideas and came up with a combination in the final design idea*."

Aware

In the current version, CAM does not allow automatic capture of information, and designers have to send messages manually. Nevertheless a collection of messages on objects enables designers to be aware of different activities. Expressing the awareness effect of the objects, one of the participants suggested: "*If you stand in front of these things* [sketches] *and scan everything with CAM, it helps you to think about and understand what's going on in the project*."

To analyze the ratings of our questionnaire, we used the Wilcoxon signed-rank test to check significant differences in experience of awareness between pre-use (n=12) and post-use (n=12) of CAM, and also to see how well design objects supported awareness. The mean scores for the questionnaire are shown in Figure 4. Our data showed a strong difference in participants' knowledge of "current state of the ongoing project" (Q6; Z=-2.620, p=0.009). Participants reported a significant difference in their "awareness of important events in the project" (Q1; Z=-2.489, p=0.013); in "establishing and retaining connections with co-workers" (Q5; Z=-2.226, p=0.026); and in their "awareness of division of work" (Q7; Z=-2.165, p=0.030). We observed a (non significant) trend of participants being able to "know co-workers' activities" (Q2; Z=-1.880, p=0.060). We did not see a significant difference in the perception of participants being part of a group (Q3, Q4) and the experience of inviting and presenting work to co-workers (Q8, Q9, Q10).

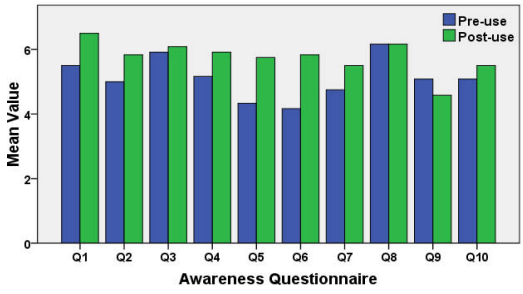

Figure 4: Mean scores of pre-use and post-use of CAM on the awareness questionnaire.

Explorative

Exploring and trying out new ideas is central to design. The augmented design objects were used for explorative purposes. We observed that designers made different versions of their ideas and used CAM to solicit comments and suggestions. For example, Figure 5a shows a design sketch describing the different interaction mechanisms of an intelligent lamp (team 3), and the following messages (translated from German) were added by co-workers as further suggestions:

```
> Responds to temperature and no. of people in the room
> Open the top and it becomes a reading lamp; close it
    at night and light will be dim
```

The *reflective* nature of explorations played an important part in supporting design. Reflections were triggered by the messages sent by the co-workers about design activities. These messages, containing comments and suggestions, lead designers to critically look at their sketches and other design objects. Sometimes, these reflections prompted decision-making and initiated face-to-face discussions.

(a) (b) (c)

Figure 5: (a) A design sketch with "explorative" role, (b) A design object where the description of planning was elaborated and "extended" in the form of messages, and (c) A final sketch of the Intelligent Lamp.

Extendable

An important aspect of tagged design objects was that each object had a digital profile (Twitter account) where relevant and complementary information could be stored. Even if the actual design objects had limited physical dimensions, the use of CAM allowed participants to extend the information pertaining to the objects. CAM allowed co-workers to write comments about a piece of work on its digital profile, as it seemed unlikely for them to annotate on the original objects. Participants described details of their objects in the digital profile by sending messages. Figure 5b shows an example where design team 1 created a planning object and stored details about their entire project plan onto its digital profile. The messages stored on this object were about dividing work responsibility, creating a work schedule and for sharing important decisions between themselves. Here are some example messages (translated from German) written on this object.

```
> Thursday: Tarek & Julia - finishing the design model
> Wednesday: Make technical drawing
> Wednesday: planning, task distribution. Grigorios
```

Playful

The way our participants used CAM and wrote messages onto their design objects had expressive and evocative qualities. CAM also seemed to provoke a degree of playfulness and creativity. Reading messages from an object had a serendipitous character, i.e. asynchronous communications through design objects had a level of serendipity. This serendipity actually fascinated the participants and made their interactions with design objects inherently playful. For example, Figure 5c shows a design

sketch of an alarm clock, where one of the design members wrote a short poem expressing what the lamp stands for. This was perceived to be funny and playful by co-designers. Following is the poem translated from German.

```
> the sun in the morning,
  the stars at the night,
  slowly accompany us into sleeping tight.
```

CAM allowed anonymity while sending messages to design objects. Coupled with serendipity, the anonymity that was supported by CAM also played a role in supporting playful acts via design objects. One of the participants commented: "*I think that sometimes this anonymity turns out to be better. I think it is less emotional and less personal when somebody tells you something through these design objects. You don't take this so personally.*"

DISCUSSION

Our findings show how augmented design objects facilitated the design process. By studying the use of CAM in a realistic setting, we 1) investigated the role of design objects in facilitating creative collaborative design, and 2) aimed at reflecting upon the vision of Ubicomp that supports the augmentation of our everyday objects.

1) The use of CAM revealed specific practices where design objects played a pivotal role. Design criticism and discussions are integral to studio-based design practices. CAM provided an explicit way to carry out discussions with reference to the design objects – keeping their sanctity intact. The asynchronous communication supported by CAM added serendipity to participants' interactions and encouraged them to negotiate and explore design ideas in a playful manner. CAM also facilitated an explicit way of documenting the design history. In long term projects, this aspect in particular could be really helpful for tracing past activities. More importantly, CAM facilitated designers to utilize the representational as well as 'appropriated' functions of design objects. Examples in Figure 5b and 5c show how CAM allowed our participants to extend the static design objects to storing digital information that supported coordinative activities (5b) and added an aesthetic layer to their design process (5c).

2) While putting the Ubicomp vision into practice, aspects such as proactivity, disappearance and seamlessness may not fit into our 'messy' everyday environments. Although CAM in its current form is not a complete or a final system, it allowed us to learn how augmented objects can be used and appropriated for supporting creative work. To this extent, CAM lets us explore design objects not as a technological enhancement, but as something that interleaves with designers' social practices and creativity. We believe that by understanding the 'use' of objects, we can optimize the fit between the technology and people's values and practices. For example, the use of poetry (Figure 5c) and the aesthetic qualities it propagated suggest that this kind of interactions is important in creative design and that a collaborative system should be able to support it. Our results echo other field studies of Ubicomp systems that have shown how people appropriate technology to bring value to their everyday interactions [e.g. 3, 12].

CAM, as a simple messaging system, is not a smart technology; instead it makes its users smart and creative enough to support their ongoing work. It is certainly useful in the domains such as logistics or supply chains that an augmented object knows its own and its surrounding's status [5]. However, this smartness may not be necessary in the context of home [3], work or other public spaces [12]. An important point we want to convey to the Ubicomp community is that the focus on Ubicomp needs to shift from *what an object can do for users* to *what values users want from the object*.

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