"Fun Place Within a Serious Space": Stimulating Community Interaction and Engagement Through Situated Snapshots In a University Setting

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ABSTRACT

Networked public displays can stimulate interaction between members of place-based communities, e.g., through situated snapshots – photos taken through a display attached camera. Previous work pointed the need for deploying networked public display applications in various settings in order to make the findings transferable and generalizable and recommends that findings should be connected with research from community psychology. In this paper we report a 15-week "in the wild" deployment of the Moment Machine 2.0 that allowed taking situated snapshots at a university. The application's evaluation involved in-depth interviews (n=20), survey (n=119), and log file analysis. We synthesize our findings with prior work and show how certain effects transfer across settings. We show how the application affected community interaction and sense of community as defined by McMillan and Chavis. We provide implications for design of similar experiences. Overall, our work contributes to the general knowledge of common effects produced by public displays.

Author Keywords

Situated snapshots; community interaction; networked public displays

ACM Classification Keywords

H.4.3 [Communications applications]: Bulletin boards; H.5.1 Multimedia Information Systems;

INTRODUCTION

Networked public displays are an emerging communication medium [6] that has the potential to stimulate community interaction – interaction between members of place-based

Figure 1. Example interaction with the Moment Machine 2.0 application. After taking a photo (left image) users would typically view their image and "like" it (right image).

communities [4] that reside within public spaces [26]. Previous work showed a variety of ways in which networked public displays can be used to stimulate community interaction, e.g., through simple video-links that connect different public spaces [7], text messages [19, 46], or photos uploaded through a website/social network [20, 32, 42]. A promising research avenue for stimulating community interaction is via situated snapshots created by means of a display-attached camera [12, 25, 33]. Besides academic work there are also a number of companies [36, 41] and startups [40] that are fully devoted to developing this type of application. Situated snapshots are fundamentally different from similar public display applications that support remote photo sharing on public displays [20, 32, 42], as they require a person to be located in front of a display to take a photo in a "mirror-like" fashion. Thus, they put the accent on situated interactions and eliminate the possibility of remote upload. This also connects to previous research [24] that explored the design space for limiting content input and access on communal public displays and pointed out the differences between "tethered" interaction that is situated and tied to a display and remote interaction via mobile devices or other means.

In this paper we report on a 15-week "in the wild" deployment of the Moment Machine 2.0 application, which allows taking and posting situated snapshots to a display network and a dedicated Facebook page. The deployment took place on four displays located at the University of Lugano (USI). Our work is motivated by prior work that analyzed existing networked public display systems in community settings [22] and showed that in order to move the field of networked public displays for communities

forward we have to a) conduct studies of existing applications in different settings in order to make their effects transferable and generalizable. As work on public displays within community settings is typically conducted for a single community in a single setting the question is what effects would a public display application produce in a different setting? What effects can be considered common/general for a type of a community oriented public display application? So far the only effect produced by public displays that has been reported in more than a single setting is display blindness [30] and/or interaction blindness [34]. Also, prior work [22] pointed the need to b) connect the effects produced by the applications with research from community psychology in order to have the reported effects grounded in theory. By doing so reported effects would further go beyond the locality where they are produced and would provide a more common, general, and transferable knowledge. Thus our research questions were:

RQ1. How can public displays stimulate community interaction within a student community via situated snapshots? To what extent are these effects transferable; are they reported in previous studies?

RQ2. How can interactions with situated snapshots impact the sense of connectedness as defined by the four properties of McMillan and Chavis [21]?

The contribution of our work is threefold:

1. The primary value of our work is a longitudinal "in the wild" study that had a goal of uncovering how effects of interacting with a type of a public display application – situated snapshots – transfer in a new setting and how these effects connect to theory from community psychology, thus looking into generalizing the produced effects (this was also ensured by having the deployed application similar to previously deployed systems). This is especially difficult for longitudinal "in the wild" studies where there is little control of factors that can influence study findings [5].

2. We present the uptake and engagement with the Moment Machine 2.0 and show the impact of interacting via situated snapshots on the community interactions of a student community and their sense of connectedness obtained through 20 in-depth interviews (n=27 individuals). A separate survey (n=119) assessed how interacting with the application affected the sense of community as defined by McMillan and Chavis [21].

3. We discuss our findings and show: how situated snapshots impacted students' interactions; transferability of the situated snapshots' effects – how effects reported in this paper connect to prior work; and how situated snapshots operate and stimulate sense of community as defined by McMillan and Chavis. We also inform the design of future networked public display deployments and applications that aim at stimulating sense of community and community interaction.

RELATED WORK
In this section we will discuss different definitions of community, prior work on networked public displays for communities in general, and more specifically prior work on networked displays and situated snapshots. Lastly we discuss how our work builds upon prior work, complements, and extends it.

Definitions of Community
There are many definitions of community [10] and the term is still continuing to change [4]. This is not surprising, as there are many different types of communities, i.e., *communities of practice* [45], *communities of interest* [8], or *place-based communities* [38]. We focus on place-based communities, as the context of networked public displays – public spaces – provide the setting for people from the same locality to interact [3, 27]. Regardless of the type of the community, a common thing for all of them is that they convey a shared sense of belonging, a *sense of community.* The most standard and used definition of the sense of community comes from the field of community psychology, where McMillan and Chavis [21] define it as: 1) membership, 2) influence, 3) integration, and 4) shared emotional connection. *Membership* reflects one's notion and feeling of belonging to a community. *Influence* refers to the ability of a member to make a change and impact upon the community and vice versa. *Integration and fulfillment of needs* relates to the reinforcement of community ties over time, e.g., by interacting with known and new community members or by contributing to community's causes. *Shared emotional connection* refers to having a shared notion of the community meaning, values, and solidarity, e.g., by participating in community events or by conducting common community activities. A sense of community can increase through *community interaction*, i.e., interaction that happens between members of the local community. Community interaction can take various forms: it can be face-to-face interaction (e.g., direct social interaction between people); contributing to building a shared history (e.g., contributing an image to a community photo collage); or participating in joint community causes (e.g., promoting the community or taking part in common activities of a community). Having a sense community is connected to having better mental and physical health [37], wellbeing in general [37], and overall a higher quality of life [16],

Networked Public Displays for Communities
One of the earliest works on networked public displays and place-based communities dates from the early 80's and the 'Hole in Space' project [13] that connected two urban spaces, one located in New York and one located in Los Angeles, through a simple video link. Similar projects were undertaken after this first installation, e.g., and more recent projects are Connected Urban Spaces [7], Hole in the Earth [14], and Telectroscope [43]. However, in recent years research on networked public displays has shifted from stimulating community interaction through relatively simple video links into creating engagement through more

interactive applications. Researchers have been investigating how to simulate social interaction between people in the immediate vicinity of displays through place-relevant information [26], by promoting and discussing topics of local importance [39] or more simple messages like "thank you" notes [31], by signaling community membership through pins and posters [17], by physical interactions across locations [29], or by shared music creation across different physical spaces [32]. Previous research has also pointed out the necessity of building display systems on top of existing practices with current ICTs [18]. The challenges of designing, developing and deploying engaging networked public display applications "in the wild" have been well documented [26, 35].

Networked Public Displays and Situated Snapshots
The work reported in this paper falls in the category of applications that stimulate community interaction by allowing people to express themselves through photos, i.e., through situated snapshots taken by a display-attached camera. Ojala et al. [33] were the first ones to document their work on situated snapshots. Their UBI-Postcards application allows passers-by to take photos via a display-attached camera and to send them to an email address that is entered on a display. Although they describe the usage of the application in the form of button clicks they do not go beyond; i.e., they have not investigated the effects of taking situated snapshots on the surrounding community. Also, photos taken via UBI-Postcards are not shown on a display network, but rather they are sent to a private email address.

The same research group implemented and evaluated Ubinion [15] that allowed young adults to take photos and augment them with comments. These snapshots would then be posted to a dedicated Facebook and Twitter account. The goal of their study was to investigate how situated snapshots can be used to stimulate civic engagement within young adults and connect them with city officials. As with the UBI-Postcards, no photos were shown on displays in the network. In a later study [12], photographs submitted through the service were analyzed to understand how users expressed themselves and also to understand possible motives for taking the photos. We complement the above works by looking into open and unrestricted use of this medium and discuss similarities and differences in findings.

Previous work has looked at the effects and use of situated snapshots of a single community located in a community center [25]. The Moment Machine application [25] allowed taking situated snapshots and posting them across the Screens in the Wild network [32]. Lastly, previous work has also analyzed privacy implications of posting and viewing situated snapshots [23]. We also want to note that there have not been many studies of networked public display applications in more than a single setting. The only one is by Akpan et al. [1], which explored how users interact with the ShadowWall application in order to

understand the interplay between space (physical setting) and place (social situation) on user engagement with public displays. However, their deployments in different settings were rather short (a day on average) and did not focus on the effects on community interaction and sense of connectedness. To this date, the only effect that has been reported across different settings for public displays is display blindness [30] and/or interaction blindness [34].

Relevance of Our Work
Prior work [22] analyzed current research on networked public displays for communities and concluded that most of the deployments are done in a single setting, which raises the question of transferability and generalizability of the reported findings. This work also pointed out that most of the evaluations focus on reporting qualitative insights from interviews and surveys, without however connecting the findings with works from community psychology. This study takes recommendations from this in two ways. The study reported in this paper builds upon prior work, as the Moment Machine 2.0 is a mix of the Moment Machine application and the Ubinion: the applicaiotn allows posting and viewing situated snapshots on a display network (similarly to the Moment Machine), but also allows posting the snapshots to a dedicated Facebook page (similarly to Ubinion). The study reported here complements the above-mentioned ones, as it investigated the use of situated snapshots in a different setting: the study of the Ubinion application reported on findings across the city of Oulu, while the study of the Moment Machine reported findings from a community center. In this paper we report on the impact of situated snapshots in a university setting, and we point out similar findings as in previous studies in order to show how certain effects transfer across different settings. Also, our study goes beyond the Moment Machine and Ubinion studies by relating the impact of the application to the sense of community as defined by McMillan and Chavis [21]. Overall, our work contributes to creating a common knowledge of general effects produced by public displays.

THE MOMENT MACHINE 2.0 DEPLOYMENT
The Moment Machine 2.0 application was developed as part of a bigger European project that had a goal of installing a display network at USI and developing applications for it. In our preliminary investigations of students' communication practices [28] we noticed that often times students would complain about the weak sense of connectedness and expressed their desires for further contact and connection. This was the motivation for developing the Moment Machine 2.0 application, i.e., to stimulate community interaction and sense of connectedness between the students. Further requirements for the application came out of various short test deployments that were conducted at the USI, as well as prior studies conducted within the setting by other researchers that looked into more general properties of networked public display applications [2, 28].

Figure 2. *Top left*: **The Moment Machine 2.0 user interface: 1) button for changing the filters, 2) button to mirror the image, 3) button for stickers, and 4) button to take the photos.** *Top right*: **The Moment Machine 2.0 user interface: 1) button to post the image to display and Facebook, 2) button to image to display, and 3) button to cancel the image.** *Bottom left*: **The Moment Machine 2.0 Gallery user interface: viewing a single photo: 1) users can see who liked their photo on Facebook, by pressing) users can see who commented on their photo on Faceboook, and by pressing 3) users can give a local like to the photo.** *Bottom right*: **The Moment Machine 2.0 Gallery: viewing comments.**

As mentioned in the introduction, the goal of the Moment Machine 2.0 was to see how situated snapshots stimulate community interaction within a student community. The application's user interface is shown in Figure 2. The application has technically two parts, one used for taking the photos and one used for viewing the photos – this part we refer to as the Moment Machine 2.0 Gallery. In addition, the application allows users to put stickers on the photos, where each faculty (informatics, communications, and economics) of USI had a sticker and there was a general USI sticker as well. The Gallery shows the last 64 images that have been taken with the Moment Machine 2.0 in an 8x8 grid. Users can click on photos to enlarge them, and for images that have been posted to Facebook they can see who liked and commented on the photo (cf. Figure 2, bottom images). They can also "like" a photo through the application's interface (this like is not submitted to Facebook). The application also has a "Hot4!" area that displays the most liked and commented images for a particular week. The Moment Machine 2.0 was deployed for the full academic semester (15 weeks) at the main campus of USI.

Overall, we deployed 4 displays in 3 buildings on campus – ground and 1st floor of the Informatics building where Informatics students have classes and where they have their open space (1st floor) free for their use; in front of the Mensa (university cafeteria) in the Main Building, which is the social hub of the campus where most of the community's social activities happen (shown in Figure 1); and on the ground floor of the Red Building where students of the Economics and Communications faculties have classes (cf. Figure 3). During the first week of deployment only one of the displays was active – in the Informatics building on the 1st floor. In the second week we added the display in front of the Mensa in the Main Building, while in the fourth week of the deployment we added two more displays – one on the ground floor in the Informatics building and one on the ground floor in the Red Building. It is important to note that the four displays had a dozen applications running on them, ranging from university news and events to the local bus schedules, and included the Moment Machine 2.0. The application ran Monday – Friday.

Figure 3. Deployment setting at USI. From left: Mensa, Red building, Informatics building ground and first floor.

EVALUATION

In this section we will describe the uptake by and impact of the Moment Machine 2.0 on the student community. We will first describe how the application was used over the course of 15 weeks. Next we will present our findings obtained from 20 in-depth interviews with application's users. After that we will show the results of our survey with n=119 respondents.

Engagement During 15 Weeks

In order to understand trends in the application's use we conducted a quantitative analysis of interaction log files collected over the 15 weeks of deployment using descriptive statistics. In total, 1382 photos were posted, 872 to Facebook (63%) and display and 510 just to a display (37%). For comparison, the overall number of photos is close to the number of photos reported for the same period of the Moment Machine study (n=1189) and higher than the number of photos reported for the Ubinion service (n=425 for 6 months period). The majority of the photos were taken through the display in the Mensa (845, 61.14%) followed by the display in the Red building (323, 23.37%). The two displays in the Informatics building were used the least (ground floor 127, 9.19%; 1st floor 87, 6.3%). Weekly average number of photos throughout the deployment is shown in Figure 4.

On average 18.43 photos were taken daily (SD 14.09) and photos received 3.52 local likes on average (SD 20.26). Overall, stickers were used on 46.89% of photos, where faculty stickers were used more (on 32.71% of the photos) than the university one (on 14.18% of the photos). If we look at the number of photos that were submitted throughout the deployment we can see that interest in the Moment Machine 2.0 application was highest when the screen in front of the Mensa was introduced (week 2) when 41.2 photos were taken on average (STD 8.66). Also, we can note two periods of engagement: a period of higher interests when the number of photos was higher than the average number of photos taken throughout the deployment – this is the first 7 weeks of deployment; and a period of lower engagement – weeks 8-15. Easter holiday was in week 10 and we can see that it may have "reset" the interest in the application and we can see a slow increase in the number of photos afterwards. A similar observation was reported in the Moment Machine study [25].
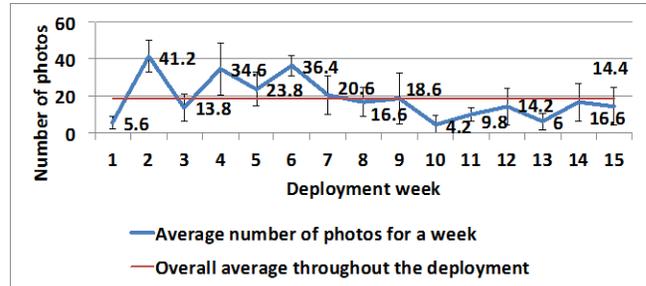

Figure 4. Weekly average number of photos taken on all displays. Error bars show standard deviation.

Engagement on Facebook is shown in Figure 5, describing the average number of unique users throughout the deployment. On average, 167.26 unique users were engaged with the application'sFacebook page (SD 139.06) on a weekly basis. From the beginning of the deployment engagement with the page was increasing and was highest in weeks 4 – 9 (all the time above the average). Similarly to situated engagement with the application, in week 10 engagement with the page was "reset" and was again increasing from that point on. Photos posted to Facebook were viewed on average 46.44 times (SD 38.58); received on average 0.40 comments (SD 0.93) and 3.11 likes (SD 4.36); and were shared 0.10 (SD 0.32) times. Overall, there was a relatively strong uphill positive relationship between the average number of posted photos and number of people that engaged with the Facebook page (r=0.63).
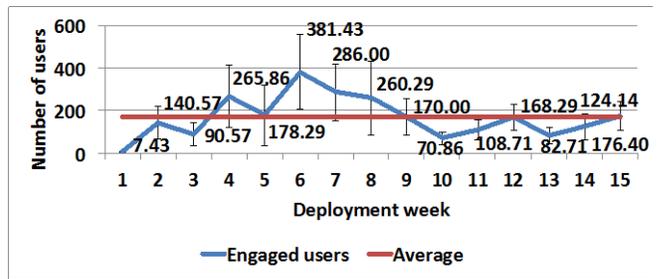

Figure 5. Average number of unique visitors on the Moment Machine 2.0's Facebook page throughout the deployment

Interviews

We started recruiting people that had interacted with the application to describe their experiences (addressing RQ1 and RQ2) one month into the deployment. In order to see if the application stimulates the same effects as reported in previous studies (addressing RQ1), the interview scheme reflected the one reported in [25], i.e., 1) general impressions of the application and reasons for taking the photos, 2) social interaction stimulated by the application, 3) impact on community interaction and awareness, 4) and how does taking photos with the Moment Machine 2.0 differ from other similar experiences, e.g., taking photos via Instagram. Overall we conducted 20 interviews with 27 individuals. We had 16 individual and 4 group interviews, interviewing 18 females (3 aged 16-20, 10 aged 21-25, and 5 aged 26-30) and 9 males (6 aged 20-25, 2 aged 26-30, and

1 aged 31-35). Most of the interviewees came to USI once a day (19) or a few times a week (6), while a minority comes about once a week (2). Interviewees reported staying at USI for 6+ hours (19), 2 to 6 hours (7), and less than 2 hours (1). We had equal number of people that had regular interactions with the Moment Machine 2.0, i.e., on a weekly basis (13) and sometimes/monthly (13), while one person very seldom had interactions (yearly).

Interviews were analyzed with the affinity diagram technique: using open-ended coding and subsequently grouping and re-grouping interview items in order to understand the similarity of the themes. Findings were then organized around the interview scheme provided at the beginning of this section that was also used in prior work on situated snapshots [25]. The goal was to see what effects are produced by interactions with situated snapshots and understand which ones generalize and are transferable across the settings. In each subsection we point out how the application was able to impact the sense of community as defined by McMillan and Chavis.

General Impressions and Reasons for Taking the Photos
Interviewees reported that Moment Machine 2.0 was the main application for them on the displays, and people associated the use of the displays solely with the applicaiton. Often times they would refer to the displays as AnonyApp and were unaware of other applications running, or they would change the application that is currently running immediately to the Moment Machine 2.0. As reported by I04: "*We don't look at other applications. We never use them. When there are other applications open, perhaps the Map of the building we change immediately to the photo, we go get the photo, get the coffee, and check the photo on our way back. […]. It's an experiment from UoX? Will it be removed? No, no, no, stay, stay, we like it, it's a good idea.*" and I13: "*Actually I interacted all the time only with this application. With the classmates, colleagues.*" or I16: "*But maybe because I see a lot of people standing here and taking pictures that my mind thinks this is like an interactive photo booth type of thingy. […] Like if I think of this structure [referring to the displays] I think of the Moment Machine 2.0.*"

Participants reported that they interact with the Moment Machine 2.0 application because it is **fun and easy**. For example, I13 stated "*We took photos with our colleagues and we posted it on Display as well and Facebook. We did it for fun.*" as well as I06: "*USI students don't study, they just take pictures. […] They might think that is a good service and a fun thing.*" Some interviewees reported using the application to **capture time spent with their friends and colleagues**. For example I15: "*[I take the photos] pretty much with everyone, like who's around. Usually it doesn't matter whom, you just grab the person coming, 'Ah, let's take a picture' and that's it.*" and I08: "*You take it [photos] because it's free and easy, and you're with different people at different times, and you wanna do something else 'Oh*

let's do something fun this time'. Yesterday for example my other friend came just to have lunch and she is also visiting [so I told her] 'You have to come see this thing' so it's just cool to show people and when you're with different people you wanna go [and take a photo]" Capturing time with people was reported by prior work [25], i.e., taking photos was part of a group's activity. Also, these activities are directly translated to McMillan and Chavis's integration and reinforcement of existing ties, as they support activities with know members as well as new ones.

Ultimately, taking situated snapshots was seen as **part of the university community's culture**, as stated by I14: "*If they [students] want to take picture they are going to stay here I hope for a long time, so as long as they are not going to be deleted from Facebook, so I would do that because of that, to keep my memories attached through the university platform […] I felt like for me it's part of my university, my university culture.*" This quote also shows how the application stimulated McMillan and Chavis's shared emotional connection, as taking photos was a common activity within the community.

Social Interaction around the Application
When it comes to stimulating social interaction, the application was able to do so within known groups as well as strangers. Similar to what has been reported in previous studies [25], reasons for talking to people were the photos themselves (inspiration for discussion), explaining how the technology works, or speculating about its purpose.

Students uncovered that the main purpose of the application was to stimulate interaction within the community, as commented by I13: "*I think the main purpose of this camera here is just to facilitate communication between the students and the staff. I think you've succeeded in that. The most of the picture are taken in a really fun way and most of them are attractive and enhance interaction.*" Engagement with the Moment Machine 2.0 application **stimulated social interaction between known groups,** both situated social interaction as well as on Facebook. A quote from I07 is a good example: "*Yes, we usually talk to people and take pictures with friends. Once we found the picture of our friend Roberto and we copied it from Moment Machine 2.0's album into our Facebook closed chat. We have a chat shared with few friends/classmates. It is a small group.*" Similar comments were made by I06: "*Yes, sometimes when we are in front of the display and we see some friends around we call them for taking a picture with them.*"

The application also **stimulated interactions between strangers.** Reasons for talking to strangers ranged from having fun to explaining how the application works. Most of the interactions with strangers were very brief/superficial and revolved around taking a photo with a stranger. For example, I04 remembers, "*It happened once that a boy was near us and we invited him. We did not know him. He was near the display and we asked him to take the photo with us. We haven't talked to him, we told him 'Bye, bye'... And*

also a professor, we think he was a professor, he was an old man. He was looking at the machine and we asked him if he would like to take the photo. We did not know these people." These brief interactions should not be neglected, as they also contributed to the sense of connectedness and solidarity, e.g., as commented by I04: *"[Do you remember any photos?] Two girls in the red building that indicated their behinds. We said 'Why have you done it?' We liked the photo. But for the solidarity [with the girls who posted the photo]. I don't like these pictures, the idea of this picture, but it's a young girl."* Overall, interactions with known groups and strangers are examples of the Moment Machine 2.0's capability to stimulate McMillan and Chavis's integration (interactions with known and new community members) and shared emotional connection (showing solidarity).

Community Interaction and Awareness
The overall goal of the application was to stimulate positive interaction between community members and sense of connectedness, and our insights show that the application was successful in that respect. More specifically, the application was able to stimulate group building as well as sense of solidarity between strangers, and in the process create a "fun" people directory and stimulate a sense of privilege. Also, interacting with the Moment Machine 2.0 was seen as part of the community's culture (cf. quote from I14 from the section *General Impressions and Reasons for Taking the Photos*). Some of these were also reported in previous studies [25] where the use of the application was described as communal and users reported having different levels of awareness of who the people that pass by are.

The application was successful in **stimulating sense of connectedness and community**. All interviewees reported that looking at the photos of friends and colleagues stimulated this sense of connectedness, and for some the connection was quite "obvious" as they are looking at photos of USI students, taken by the USI's Moment Machine 2.0 application at USI. Making this connection was possible only for the community members, as stated by I02: *"Because I'm part of USI I can see it, people from outside wouldn't make the connection, I have seen these faces all over the campus in the last years. So for me those are USI students, but, if the logo is not on the photo there is no connection"* This connection was also stimulated through the possibility to "brand" yourself through stickers and be part of "something bigger". This is best captured by a quote from I08: *"[USI student] Well the people in the photos are students here for the most part, and I like the stamps; you can show which faculty you're in or just have the USI stamp. Kind of symbolizes being a proud USI student and happy to go here, see people laughing and smiling in the pictures; it's a good representation of the student body. [Visitor] I feel the sense of togetherness. It's a small school. Seeing people together it really shows that students are close here and closely knit. And despite it being clique-y, they are grouped together as oppose to*

everyone being alienated on their own, it's a very nice way to showcase that." These quotes show application's impact on McMillan and Chavis's membership – knowing who the members are and feeling like part of the community; and integration – reinforcement of ties by looking at familiar faces, which in turn also stimulated shared emotional connection.

One of the successes of the application was that it stimulated group building between people who knew each other by allowing them to take photos after achieving a certain milestones, e.g., end of a semester project or a successful team meeting. However, the application also stimulated sense of solidarity between strangers. Overall, the application allowed students to create their own place within the university – a fun place within a serious space. This is best captured by I01: *"[...] it definitely shows people that study here and what you can see, here you can see that everyone is making jokes and fun and it creates a nice overall experience, people are having fun and if you're not having that much fun than you say 'Oh why I'm not having fun, they are having fun, let's have fun' and then everyone is happy, it creates a good state of mind."* This also shows how the Moment Machine 2.0 impacted McMillan and Chavis's influence, where students created their own space within the university setting, thus changing the relationship.

One of the interesting purposes that emerged from the application's use was a "**fun" people directory**. Students reported recognizing friends and others they know on the photos, but also they would use the application to get more information about people they do not know. In other words, people would use the photos captured through the application as a reference point: when they see someone they know or like they would often get more information about that particular person on Facebook. As captured by I11: *"Boys use it in a special way: if they see a nice girl they try to find her contact by asking friends about the picture(s) [...] For example, I was just talking with a friend that liked a girl a lot and he is trying to understand how to contact her. He didn't succeed yet."* The "fun people" directory allowed uncovering newcomers (new students) at the university, but also supported catching up with friends and their activities, e.g., I18: *"What I've noticed was that when I took class with some roommates, we took pictures together. Now we are following different courses and we're taking different pictures. It is also because we have different schedules, but sometimes I saw, oh look at there, they are all my friends, but I'm not there because I was following another course at that moment."*

The Moment Machine 2.0 **stimulated a sense of privilege**, and students saw it as improving USI's image as an institution. Students liked that the application was personalized for USI – there is the "USI Moment Machine" in the title, and photos can be personalized or "branded". Also, they are attending the only university that has it, e.g., I06 *"This is school! It is a special network shared just by*

us: USI students. We fell like VIP and the Moment Machine 2.0 application is a special network that is exclusive for us." Interacting with the application was seen as an exclusive action, e.g., I11: *"Like this is perfect, having just a few displays make it special. You have to fight to take a picture during the pause and that's cool."*

Uniqueness of Situated Snapshots
Students also commented on their experience of taking situated snapshots through a display-attached camera in comparison to other similar media, e.g., mobile phones, Instagram, or digital cameras. The medium was described as social selfie, allowing students to take unconventional photos. It was also different from other media, as its focus was more on the local interactions. This relevance of the locality was also mentioned in previous studies [25]. Also, previous studies reported on the inclusive and egocentric nature of the medium – this can be connected to the above-mentioned sense of privilege and the need to "fight" for the time to interact with the application.

Taking photos through the application was similar to taking a selfie, i.e., a self portrait photo, but it was characterized as a *more "social" and "group" selfie, almost like an anti-selfie*. This is best captured by a quote from participants I02: *"This is much more fun because you don't take a photo by yourself, you take a photo with your friends, you have fun and you laugh about the photo, then you share the photo, then you post comments about the photos [...] it encourages social interaction between people that took the photo and it's fun for them. With my phone I just take a photo and post it on Instagram and over there [the interaction is] finished."* and I16: *"Displays are more social because you interact with people in two ways, through the display but also directly [...] you are in a group, you play with the displays, so maybe someone that you don't know comes and joins, while on Instagram, as I use it, I never share any content. I look at other people's pictures."*

The Moment Machine 2.0 *allowed taking unconventional photos* that one would not usually take with a phone. As mentioned in the previous section, taking photos with the application was seen as very exclusive and personalized

activity just for the USI community – it was seen as something that others do not have. This also made the experience different in comparison to other media. Lastly, students did mention that locality was also a distinguishing factor. For example I07 describes this property: *"Facebook and Instagram are more personal. The Moment Machine 2.0 is a closed network where just we see the pictures, and we can post weird pictures [...] The Moment Machine 2.0 is complementary to Facebook but different. I cannot use one instead of the other.*"

Survey
We distributed a short survey to the students within the last two weeks of the deployment using various university and faculty mailing lists. The goal of the survey was to reach a wider audience and assess how interactions with the Moment Machine 2.0 impact the sense of community as defined by McMillan and Chavis. Overall, the survey asked about participants demographics, how often they are at the university and for how long they stay, what the effects of applications' use are, and if they have any other comments about the application. Overall, we received 141 survey responses out of which 22 participants reported that they never used the displays. The subsequent figures refer to the 119 responses that reported frequent or occasional use of the displays. Most of the participants reported coming to USI on a regular basis (once a day 84.87%, a few times a week 11.76%) and spending more than 6 hours on campus (between 6 and 8 hours 41.18%, and 8+ hours 30.25%).

Impact of the Moment Machine 2.0 Application
The strongest indicator of the overall application's impact comes from the part of the survey that asked the participants for their level of agreement/disagreement with the statements that reflected the application's impact on the sense of community. In Figure 6 we can see that a majority of the participants agreed with all the statements. In other words, participants agreed that the application reflected the USI community (60.5% of the participants agreed) and saw posting photos through the Moment Machine 2.0 application as a common (i.e., shared) activity for the members of the USI community (52.94%). The majority of
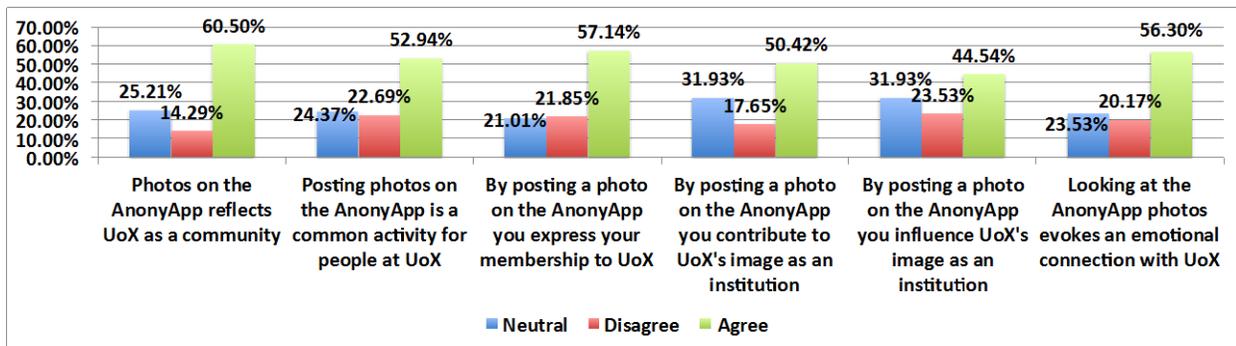

Figure 6. Level of agreement on the overall influence of the Moment Machine 2.0 application on the sense of community. Statements were targeting (from left) the application's ability to reflect the USI community, its integration within the community, its ability to affect membership, integration and fulfillment of needs, influence, and shared emotional connection. Levels of agreement/disagreement were grouped.

the participants also agreed that by posting photos through the application they are expressing membership to the USI community (57.14%) and contributing to USI's image as an institution (50.24%), thus making their influence on how it looks and feels (influencing its image, 44.54%). Finally, the majority of the participants agreed that looking at the photos evokes an emotional connection with USI (56.3%).

Open-ended feedback further confirmed some of the interview findings. For example, the application's ability to stimulate the sense of community – *"captures emotions throughout the day, and the feeling of a connection with USI"*; *"The memories that remain: even though they are simple photos I will remember years spent at USI, my classmates...etc.";* or *"In a sense brings people together at least for a moment: 'C'mon guys, lets take a photo together'"*. Open-ended feedback also confirmed the application's ability to capture everyday moments at USI: *"Possibility to capture some of the most interesting moments: birthday of my friend, post-exams...", "Possibility to keep/remember those moments from everyday life from USI."*. These quotes directly show impact on McMillan and Chavis's notions of membership, integration, and shared emotional connection.

Participants also commented on using the application as a **stress relief** from their work*: "To see happy faces even when it seems that everything around is difficult. Realizing the vitality that we young people have."* or *"It's fun to pass by and see the photos that makes you laugh and makes you forget the university stress at least for a brief moment"*. There were also comments on the application's use for the promotion of USI and its life *"Thanks to the Moment Machine 2.0 we've demonstrated through Facebook the world of USI to our friends/families"*.

There were not that many negative comments for the application and mainly went on speculating about what the application does/what its purpose is: *"Maybe there is a video camera that before taking a photo records a movements in front of the display."* or *"I don't understand usefulness of this application, nobody has explained what is its purpose."* There were also comments on how to improve the application's technical aspects, e.g., filters and responsiveness of the touch screen. An interesting comment made by several respondents was on how the application's use sometimes blocks the pathways in buildings where displays are located, e.g., *"it is blocking the way to Mensa"* or *"It is an obstruction on the way to the Mensa or in the Red building, especially when large groups try to take a photo."*

Our overall evaluation focused on understanding the impact of application's use on students' interactions, and did not consider students that did not interact with the application. This was a rational decision given our research questions, which looked into the effects of interacting through situated snapshots and their transferability across the settings. There were scarce comments from the survey participants that did not interact with the application (n=22), which mainly questioned why the university is spending money on displays and not on investing in new courses.

DISCUSSION

We discuss in this section the impact of interacting with Moment Machine 2.0 on students' community interaction; potential improvement of the application; transferability of the situated snapshots' effects; and how they make an impact on McMillan and Chavis's sense of community. In our discussion we will also inform the design of similar applications and networked public display deployments.

Impact on the Students' Community Interactions

The Moment Machine 2.0 allowed students to express themselves and to capture positive moments spent with their friends and colleagues. Interactions through the use of application stimulated casual interactions, familiarity and awareness, and fun. Although our findings do not show clear instances of strong ties emerging from these interactions, these types of interactions could potentially facilitate deeper community building, as well as open opportunities for other technologies that stimulate community building.

There are several ways in which the aplication could be improved. For example, the application could be tuned to show photos from different time periods when students had fun (e.g., events) as at the moment it shows the last 64 photos. In order to allow more personal as well as group interactions, the application could support individual tagging of the photos using a hashtag (complementing current stamps) – this could also support natural emergence of different sub-communities that thrive within a larger community. As the use of the application served the purpose of a "fun people" directory, this could be leveraged in order to further unite the community, e.g., photo challenges could be organized where members would be asked to replicate a certain pose, potentially challenging a particular individual to do the same. Similar challenges could be organized in general, e.g., where students would be asked to take the photos with the biggest number of friends or strangers in the picture or the biggest number of university logos/symbols and outfits.

Transferability of The Situated Snapshots' Effects

We can say that people take and view situated snapshots because it is fun and because they can take unconventional photos. In turn, this makes an impact on community interaction and awareness by stimulating interaction between people that know each other, but also between strangers that are taking the photo. Overall, these activities allow people to capture memories and time spent with their friends/colleagues and to keep them attached to a specific setting – in our case the university. Viewing photos creates awareness or even a "fun people" directory that conveys the notion of who is around and who is the member of a community. Ultimately, as reported by our interviewees and survey respondents, these activities become part of the

community's culture. Similar patterns of use and similar effects have been reported in previous studies, which point to fun and playful aspects [12, 25] as motivations for taking the photos. Also, previous studies report how situated snapshots stimulate social interaction and awareness of different community members [25], without however making the link that posted photos form a people directory.

General features that all of the situated snapshot applications support are taking photos [15, 25, 33], looking at the photos on a display [25] and other places, e.g., Facebook or Twitter [15]. Our interviews uncovered that users appreciated that the Moment Machine 2.0 was not a generic photo-taking application, but rather was customized for them and the location – the UI reflected the University's official design and the application also supported stamping the photos that were personalized for the location. In turn this influenced their sense of connectedness. This is an interesting finding for the designers of similar future applications, as it points out *the need for having more personalized applications whose actual graphical design reflects the location and the place-based community where a display is located*. As mentioned by the interviewees the use of the application also gave them a sense of privilege. Having a personalized design becomes even more important for the future where universities and other settings would have display networks with similar applications. The question remains to what extent this sense of privilege can persist once certain application becomes truly ubiquitous – this can be influenced by limiting the flow of the content and places where it appears.

Taking situated snapshots differs from other similar media where people can post photos, e.g., Facebook or Instagram; this difference was described as situated snapshots being more social and community oriented, whereas other media was characterized as being more personal. Previous studies [25] have reported on similar findings that situated snapshots differ from other media as they have a certain local reach, i.e., they are an interesting medium only if there are locals that know about it. These are interesting findings as they show how networked public displays can fit in within existing media by creating exclusive place-based networks. Our findings would suggest that *tethered display content would be more effective in stimulating community interaction and creating engagement than "free to roam" content that appears anywhere* [24]. Future designers and developers can leverage this finding by optimizing their efforts in the design process and focusing on a single device and platform (vs. supporting also interactions via mobile phones and/or multiple existing social platforms). Also, the impact of tethered content and user input on community interaction can be further examined, e.g., by examining the impact of adding a certain physical place where a display is located or by examining the impact of the possibility to post content to other digital media (e.g., Twitter, Instagram etc.).

Situated Snapshots and McMillan and Chavis's Sense of Community

The way situated snapshots operate and stimulate a sense of connectedness can also be linked to the four factors that create a sense of community as defined by McMillan and Chavis: **membership** – by posting to a display, a person is declaring their membership in a community, and by looking at the display's content a person can also see who the members are; **influence** – by posting to a display a person is influencing the display's overall look and the community that is using it, as well as the community setting where the display is located; **integration and fulfillment of needs** – by interacting with known groups and strangers, and posting and looking at a display content over time, a person reinforces their connections within the community, and in this process joins a common community activity; and **shared emotional connection** – by posting to a display and looking at its content, a person creates a connection with others who share their values. This type of behavior can be generalized to a certain extent: *capturing group activities or collaborative efforts and exhibiting them on a display as a collective showcase can be a successful way of stimulating community interaction*. For example, a similar "casual" application that would allow creating collaborative art in the form of graffiti or any other type of drawing, in combination with showing all the artwork on a display, would likely also stimulate a sense of connectedness.

CONCLUSIONS AND FUTURE WORK

In this paper we report on the 15 weeks long deployment of the Moment Machine 2.0 on 4 displays at the University of Lugano. Our work has shown how certain effects of interacting via situated snapshots generalize and transfer across the settings, and has connected their impact with McMillan and Chavis's sense of community [21]. Thus, we contribute to the buildup of common knowledge of how public displays operate and what effects they produce.

Future work can look into redeploying different types of applications in different settings, e.g., applications that support crowdsourcing [9, 15] or civic engagement [39, 44]. When it comes to future work on situated snapshots it can examine technical aspects of posting/viewing situated snapshot that would create more engagement, e.g., creating photo-streams that allow capturing multiple photos, or examining the impact of different layouts of picture galleries; Or can look into deepening the understanding of the effects produced by interactions with situated snapshot, e.g., at what time do interactions start affecting sense of community and when do they (potentially) loose their effect.

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