Multiplicity through connectivity: investigating body-technology-space couplings in participatory activities

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ABSTRACT

We report on a participatory design workshop, which consisted of diverse activities in which participants explored the concept of "connectedness" in various ways. The aim of the workshop was to facilitate multiplicity as a generative strategy to be used in early phases of design. In this position paper, we focus on the machine-mediated performance session of the workshop, in which participants extensively used their bodies to explore ways to couple with technological tools, their partners and the space. The aim of the performance session was to facilitate multiplicity in couplings between body, technology and space. We analysed the activities according to a coding scheme involving Laban's effort categories. We explain how the various forms of connection between bodies and different technological tools were constructed in each activity. We discuss how connectivity of technology can be used to support multiplicity in design.

Author Keywords

Multiplicity, connectivity, participatory design

ACM Classification Keywords

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

INTRODUCTION

In our research study, we aim to support the multiplicity and richness involved in human agency in order to generate inspiring ideas and open up possibilities in the early phases of design. To this end, we conducted a participatory design workshop, which was part of a series of participatory design workshops (Kocaballi et al., 2010) organized to bring together diverse activities facilitating multiplicity. The focus of workshop was upon concept of connectedness and the multiple ways of performing connections between humans and between humans and technologies. We considered connectedness to be a suitable concept for our explorative process as it enables us to focus on relations between the entities rather than on the entities themselves.

There is a growing body of research built upon embodied and relational perspectives (Boehner et al., 2005; Dourish, 2001; Gaver et al., 2003; Wei, 2007) in the domain of interaction design. These studies embrace a relational view of human agency and augment its multiplicity, richness and relational nature. For example, Wei (2007) explores interaction, gesture and agency through what he calls performative phenomenological experiments as tools for philosophical inquiry. In Wei's TGarden project, a media-rich responsive space, actors-spectators improvise gestures with specially designed costumes equipped with sensors. Similarly, we undertook performative phenomenological experiments in the form of participatory design workshops.

In this paper, we report on our workshop with two interaction designers. Our focus is upon the machine-mediated performance session, in which the workshop participants extensively used their bodies to explore ways of coupling with technological tools, their partners and the space.

PARTICIPATORY DESIGN WORKSHOP

Participatory design workshops, with their emphasis on negotiation, diversity and co-construction of meaning (Muller, 2003), provided us with a suitable play platform. Our participatory design workshop involved two 22-year-old female interaction designers, who were close friends and had worked together before. The workshop consisted of four sessions lasting approximately 4 hours in total: a silence session, a physical sensitivity session, a rich-poster session and finally a performance session. In addition to participants discussing their experience after each session, there was a separate reflection session at the end that allowed participants to reflect on their overall experience. We selected the activities in the sessions according to their capacities to facilitate what Law (2004) refers to as multiple ways of knowing.

In the silence session, participants were asked to close their eyes and concentrate on the existence of their own and their partner's body and space. This session aimed to increase the participants' awareness of themselves and of others' selves.

In the physical sensitivity session, participants performed physical exercises encouraging interaction through body movements. These exercises were structured to help participants to understand and analyse elements and qualities of the space, and take these qualities up, or allow these qualities to come through their bodies.

In the rich-poster session, participants made a collage of pictures, texts and objects on an A0-paper sheet. The aims of this session were to understand what "connectedness" meant to participants, to increase their awareness of the

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concept and to see different forms of connection on a shared medium.

In the final machine-mediated performance session, participants performed five short activities using three technological devices: two wearable devices with tilt and distance sensing capabilities and one webcam with image processing capability. The aim was to explore different forms of connection with other bodies and space through technologies, which allowed participants to create various sound effects through their body movements. Participants played with the technological tools and experimented in different ways to communicate with their partners and co-compose sound effects.

The machine-mediated performance session

We used different sensing technologies to facilitate various connections between bodies, technology and space. The session consisted of five short activities using five sound-generating technological devices: two Wii-motes, two rangefinder devices and a webcam. These devices represent three different ways of coupling between human, technology and space. Wii-motes generate sound effects based on movement in vertical and horizontal dimensions: the rangefinder devices produce sounds based on the changes in the distance within 70cm range. The webcam detects motion and triggers musical notes according to the place of motion in space. Each device differs in its particular way of capturing body movement. While the Wii-motes sense the movement of human body fairly independently of other bodies and the space using measurements in vertical and horizontal axes, the rangefinder devices sense the movement of the body in relation to other bodies or entities in space using a directional distance measurement. Finally, the webcam senses all of the motion within its field of view producing sounds from the movements of all of the bodies in space. While the Wii-motes and the rangefinder devices need to be attached to the body, the webcam can be placed somewhere in the space detached from the bodies. We also provided the participants with various straps allowing them to attach the devices to any parts of their bodies. The multiplicity in capacities of technological tools and ways of coupling with the technologies allowed participants to explore and perform various connections through their movements and sound effects.

In addition to using different sensing technologies, we played with the degree of coupling between the wearable devices (i.e. Wii-motes and rangefinder devices) that was encoded in the software. When two devices are coupled, the sound producing system gets sensing data from each device and combines them to produce a single sound effect. Thus, participants using the coupled devices do not have a total control over the generated sound effects. They have to coordinate their movements to shape sound composition. However, when the devices are decoupled, each device produces a separate sound effect independent from the other device. A different sound effect is assigned to each device.

Participants used decoupled Wii-motes, coupled Wii-motes, decoupled rangefinders, coupled rangefinders and finally webcam in each activity respectively. We were interested in whether a pre-set connection or coupling between devices facilitates more collaboration and creative engagements between participants. Each activity lasted about 3 minutes. Participants had a chance to play with the devices and select the sound effects before each activity.

Analysis methodology

All activities were video-recorded for retrospective analysis. We segmented the video sequences according to the different body-technology-space arrangements. There were various arrangements during a session but not all of them allowed participants to create a connection, in which they were able to coordinate their movements and co-compose sound effects. After watching the video sequences multiple times, we concluded that the arrangements that lasted less than 3 seconds did not involve a connection between participants and could be considered as connection attempts only. Thus, our video segments included the arrangements that lasted 3 or more seconds. We analysed video segments by using a coding scheme, which included ten codes: form of body-technology-space arrangement, connection strategy, duration of connection, mobility of participants, proximity of participants, movement qualities of two participants, technologies, mapping strategy and finally the sound effect (see Table 1). We used Laban's effort categories (Laban, 1971) to describe movement qualities of participants. Laban's effort categories are useful for describing the temporal and dynamic qualities of human movement. There are four categories, each of which had two polar values: i) Space: Direct/Indirect; ii) Weight: Strong/Light; iii) Time: Sudden/Sustained; and (iv) Flow: Bound/Free. When coding the segments, we also consulted our transcriptions of the reflection sessions of activities. This allowed us to better read the connection.

RESULTS

Activity 1 using decoupled Wii-motes

There were seven different connections constructed in the activity. The average duration of a connection was 14 seconds. The most prominent result was the same qualities of movement for both participants for all

Arrangement	Connection via	Duration	Mobility	Proximity	Movements-P1	Movements-P2	Devices	Mapping	Sound
	Movement strategy of making similar movement patterns.	00:26-36, 8sec	2Ps St	2Ps close	strong in weight, sudden in time, direct in space, bound in flow	strong in weight, sudden in time, direct in space, bound in flow	2Ps 2Ecs	Devices decoupled	Electronic Screaming, gun shot, discrete sound

Table 1. The coding scheme for analysis of connections between 2 Participants (Ps) and 2 Rangefinders (RF).

connections in the activity. The qualities of movements were mostly strong in weight and always bounded in flow. However, the qualities varied in time and space. The participants constructed the connections by talking, observing and using the strategy of making similar movements and mimicking. Three of the seven connections were constructed by verbal communications such as "*we are all robots*" and "*let's do the similar, up!*" The participants preferred to be in face-to-face position and maintain eye contact. They said that although they did the same movements, they could not get the similar sound effects. They expected similar responses from the devices but the responses were different. The different types of sound effects and the mapping algorithm caused the differences between devices' responses. However, this did not cause any problems in constructing the connections but definitely changed the characteristic of the connections. After the first two connections, the participants did not use the straps.

Activity 2 using coupled Wii-motes

Participants found it hard to coordinate their movements and figure out the mapping algorithm employed. There were four different forms of connections but, in fact, they were parts or phases of one main connection, which was based on the participants' idea of creating an effect of a slowly gathering storm. They said that having a theme for the activity helped them to coordinate their movements and hence create a connection. Their movement qualities according to the Laban's categories were always varied and did not show any common patterns. The only common pattern was the bounded flow of their movements. Although the participants could not achieve the desired storm effect, they systematically experimented different possibilities of connections using verbal communication and strong eye contact. The average duration of a connection was 8 seconds.

Activity 3 using decoupled rangefinders

This activity was the most fruitful one in terms of the variety of connections. Participants performed 14 different connections most of which was over 10 seconds. They used verbal communication only three times for coordinating their movements: the body language and eye contacts were sufficient. Their main coordination strategies were doing the similar or opposite movements. Their movements had the same qualities in eight activities. All qualities of movements varied across the different connections except the quality of flow, which was again bounded for all connections. One participant said that her device's sound effect was not as powerful as her partner's so she decided to use it as a background rhythm and made repetitive movements. Another participant maintained that the limited sensing capacity of the devices made them more explorative. The longest connection, 35 seconds, was performed in this activity.

Activity 4 using webcam

The webcam activity resulted in 12 different forms of

connections, which were radically different from the previous activities in terms of positioning of bodies and movement qualities. The webcam allowed participants to use their full body in many different axes. They did aerobic movements and even a headstand. Their movements were usually sustained in time and indirect in space. For the first time, the flow of their movement was free for some connections. They used many different parts of the space and did not need to be close to their partners in space. The participants liked the flexibility in creating sound effects and 'tool-less' freedom of interaction. The average duration of a connection was 13 seconds.

DISCUSSION

When the participants were using Wii-motes, they decided to create harmonic sounds and movements. They systematically tried many different combinations of movements, e.g., doing the same movement at the same time; doing the opposite movements at the same time and doing movements at different speeds. The capabilities of Wii-motes did not invite participants to make movements involving multiple bodies at the same time.

The rangefinder devices had a limited range of sensing. However, the distance was a special kind of measurement that required the existence of two things to be in a particular physical arrangement. This characteristic of the devices invited participants to experiment, that is, to try various ways of creating spaces in between the different parts of a single body, in between the different bodies and in between the bodies and other things in the space. So, although the device had a very limited sensing range, there was a broad variety in interactions and connections.

The webcam's motion detection capability supported the use of full body movements in many axes in many different ways. The movements of participants were free in flow only in this activity. Since the camera detected any motion in its field of view, it was hard for the participants to recognize the effects of their own movements, which is a critical requirement for creating and sustaining a connection between human and technology. However, the participants dealt creatively with the difficulty of recognizing their own effects. For example, one participant became stationary and made repetitive movements while the other participant walked in and out of the camera's field of view making sweeping arm movements in many axes. In this way, each participant was able to observe her movements' contribution to the sound effect.

Coupled vs. decoupled

The strategy of coupling the wearable devices did not work well for supporting more collaboration and creative engagements between participants. The participants did try to collaborate with their partners more when using the decoupled devices but the pre-defined relation between the devices limited the participant's expressive capacity. They usually looked for a very direct one-to-one mapping between their movements and sound effects. However, the combined controls made it extremely hard for them to get the desired sound effects by using their own movements. The participants found the control of the coupled devices boring as they were not able to access to the whole set of musical notes. One participant said that "*the combined one might be more interesting but we* *should not compromise our own capacities*". In general, coupling the devices might be suitable for free-play but if there is task-oriented activity, it can be frustrating and be perceived as an obstacle. One important point about using coupled devices is that the researchers should provide the participants with sufficient time to learn and experiment the coupled capabilities of devices. In our case, the duration of three minutes was not sufficient for participants to develop a common understanding of working principles of devices.

Multiplicity through connectivity

The connectivity can be defined as an entity's ability to make connections. Based on the usage patterns of technological devices in the activities, the connectivity of the devices can be sorted from the highest to the lowest as follows: the webcam, the rangefinders and the Wii-motes (see Figure 1). The webcam with its ability to capture any motion in space allowed participants to use any parts of their bodies to create sound and, hence, make a connection. It provided the participants with the highest possibility of making connections. Similarly, the rangefinder devices with their ability to capture distance between any two points provided the participants with endless opportunities to create sound. In contrast, the Wii-motes invited participants to use them in a very specific way. In order to use their full capacity, one needs to hold them by his/her hands otherwise one's capacity to generate sound effects diminishes radically. For this reason, participants almost always preferred to use them by their hands and did not use the straps provided to them.

The webcam and rangefinders with their high degrees of connectivity facilitated the creation of many different connections whereas the Wii-motes with the low degrees of connectivity could only support the construction of a few connections. This finding suggests a positive relation between connectivity and multiplicity: increasing the connectivity of a device may prove useful for increasing multiplicity. However, the quality of connections can be also as important as the multiplicity of connections. For example, the low granularity of the webcam's sensing capacity could not capture the rich variation of human movements in different connections. This indifference to the variations affected the participants' sense of connection. In many cases, although they felt a connection, it was a very weak one for them to maintain their interest in longer periods of time. This was not a problem for our study since we aimed to obtain as many different forms of connections as possible. However, a few long-lasting connections might be more insightful for different studies. Here, the types and aims of the projects are the main factor for making a selection between the multiplicity of connections and the quality of connections.

The machine-mediated performance session was successful in terms of supporting multiplicity in connections. The high level goal of workshop was to integrate what we refer to as Agency Sensitive Design (ASD) qualities into design process. There are six ASD design qualities: relationality, visibility, multiplicity, configurability, duality, and accountability. For an extended presentation of ASD approach and its qualities, please see Kocaballi et al. (2011).

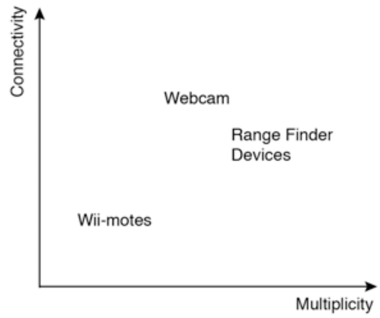

Figure 1.Three devices, connectivity, and multiplicity

Each workshop session embodied at least one ASD quality. We aimed to integrate qualities of multiplicity and configurability into the machine-mediated performance session. While the quality of multiplicity was effectively supported, the quality of configurability could not be supported. We attempted to support configurability by making compact wearable devices that were attachable to different parts of the bodies by using various straps. However, the participants did not use the straps and held the devices by their hands only. The lack of expressive capacity in many of the configurations rendered those configurations useless or not preferable. This finding suggests that the difference between the expressive capacities of alternative configurations should not be very high in order to support configurability.

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