

Embracing relational agency in design process

Abstract

Our research investigates how the design process can accommodate a relational view of agency. According to the relational view, agency - or capacities of action - is neither an attribute of subjects nor of objects. The relational view of agency in design may allow designers to recognize and support the diversity and richness involved in human agency. To this end, we developed six design qualities to embrace the relational view of agency in design process. Using these qualities, we have created design inscriptions in the forms of materials and process constructs and applied them in a series of participatory design workshops, focusing on the notion of connectedness. We present how effective our inscriptions were in supporting the ASD qualities in each workshop.

Keywords

Design process, relational agency, participatory design, Actor-Network Theory.

1 Introduction

The concept of agency is defined in its simplest sense as the capacity for action or transformative capacity [1]. Yet, there has been ongoing debate surrounding definition, emergence and possession of agency in artificial intelligence, cognitive science, philosophy and many other fields. One particular point of controversy is related to the attribution of agency to entities.

As opposed to the traditional humanist view of agency as a property of individual entities, Barad [2] suggests that agency is not an attribute of subjects nor of objects or systems but is the ongoing reconfigurations of the world, an enactment. Agency emerges out of the dynamism between entities.

Our research aims to explore how design process can embrace the relational nature of human agency. We suggest six qualities to characterize a more relational design approach referred to as Agency Sensitive Design (ASD): relationality, visibility, multiplicity, accountability, duality and configurability. We used qualities in a similar way to those featured in Bardzell's [3] study. Bardzell developed a "constellation" of design qualities as part of a feminist interaction design program focusing on values like agency, empowerment, diversity and social justice. The qualities we propose are similar to those developed by Bardzell. However, somewhat different from Bardzell's approach, our qualities primarily focus on ways of promoting relational agency: more in the nature of process-oriented qualities characterizing how a design process might embody a relational view of agency, our qualities provide conceptual lenses through which to gain a relational understanding of the situation. As well, they aim to increase the designers' awareness of relationality of human agency, i.e., the relational, embodied and situated characteristics of human action, allowing them to tune their practices to recognize and support the diversity and richness involved in human agency.

In the paper, when required, we used the term human agency as a convenient way of highlighting the main actor of interest in a situation. It is a term just to refer to the human side of the relational agency. It is not problematic to use 'human' in front of agency as long as one is aware of the relational nature of agency. In this study, we run two parallel streams of research: research into ways of integrating ASD qualities into design process; and research into various forms of connections between humans and technologies. In parallel to this, our evaluation has two streams: we evaluate the forms of connections and, as well, our ways of exploring the forms of connections.

2 Design and Agency

Design activities, in varying degrees, ultimately aim to create, modify, enable and/or constrain some capacities of action through designed artefacts. Designers inscribe values, visions, programs of actions and modalities of perception into technology design. Akrich [4] explains the notion of inscriptions in technology design in the following way:

Designers thus define actors with specific tastes, competences, motives, aspirations, political prejudices, and the rest, ... A large part of the work of innovators is that of "inscribing" this vision of (or prediction about) the world in the technical content of the new object. To be sure, it may be that no actors will come forward to play the roles envisaged by the designer. Or users may define quite different roles of their own [4, p.208]

The technical content of the objects embodies a script similar to a film script, defining the actors, roles and their settings [4]. A script involves, in varying strengths, "programs of action" that are "translated" in practice [5]. Translations are processes in which "the identity of actors, the possibility of interaction and the margins of manoeuvre are negotiated and delimited" [6, p.203]. However, should the translation processes vary, these inscribed programs of action may not succeed; in addition, actual interactions between entities may unfold in unexpected ways.

The strength of an inscription may vary from very strong, that is, imposing one particular inflexible program of action, to very weak, offering many flexible programs of action. Increasing the strength of an inscription can also be considered as an attempt

to confine the relational character of human agency. Strong inscriptions belong to a perspective of design that aims to predict, prescribe and control the kind of relations between humans and technologies and the ways in which their interaction unfolds. Repeatability, consistency and reliability are particular kinds of qualities that characterize the human-technology interactions shaped by strong inscriptions. Although these are definitely desirable qualities for some settings such as legal, medical and educational, they may not be very suitable for some other situations where appropriation, personalization, adaptation, entertainment and exploration are needed [7]. In practice, the human-technology interactions may happen in unexpected ways or as Akrich [4] pointed out users' definitions of roles may deviate from the intended roles. Thus, rather than assuming agency as a predictable and fully controllable phenomenon, we may acknowledge its relational character and develop sensitivities to manage relationality in the design and use of technologies. In this way, we can see relationality with its ambiguities and contingencies as a resource for design [7] [8] and formulate design solutions to deal with unexpected situations that may happen during the use of technologies.

3 Towards a Relational Approach to Design

A relational approach to design process might be beneficial in many ways: i) it provides resources and mechanisms to deal with unexpected situations [7] [8]; ii) it supports responsible and ethical practices by recognizing and supporting different and marginalized actors, and their ways of knowing and doing things [9]; iii) it supports the creative potential of users by supporting user appropriation and what Aanestad [10] refers to as design in use; and iv) it supports innovations by making design process as open and as inclusive as possible [11].

Our approach to developing a relational approach to design is referred to as Agency Sensitive Design (ASD). Our aim is not to replace existing design methodologies but rather to complement them by developing sensitivities in the form of design qualities. The fundamental principle of ASD is recognizing and supporting variety in the formation and exhibition of agency in the design and use of technologies. This principle includes a large range of aspects

of relational agency in design. In a design process, while the formation of agency refers to the construction of a heterogeneous network or assemblage of human and non-human actors, exhibition of agency refers to the effects of that network. We need to recognize the influence of multiple sources on design problems and then find ways to consider their concerns and effects. Similarly, we need to support variations in the network's effects, i.e., the collective actions of actors. However, it is important to note that variations in the network's effects may not be desirable for safety critical or high reliability required situations. Thus, relationality should be tailored very carefully in these cases.

Drawing upon the extant works and approaches in Human-Computer Interaction, Participatory Design, Actor-Network Theory and Science and Technology Studies, we developed six design qualities: relationality, visibility, multiplicity, configurability, accountability and duality. These broad categorical qualities, which may overlap and be further divided into a few other qualities, provide a useful starting point from which to articulate some of the implications of a relational view of agency for the design process. As well, they aim to increase the designers' awareness of relationality, allow them to tune their design practices to accommodate the diversity and richness involved in human agency. In the next section, we will explain these qualities briefly. For an extended presentation of these qualities, please see [12].

3.1 Relationality

The quality of relationality refers to the connectedness and relatedness of human and non-human actors comprising heterogeneous networks [5] or socio-material arrangements [13] in which humans and non-humans co-constitute each other through their interactions. According to Suchman, relationality emphasizes the "relational character of our capacities for action, the constructed nature of subjects and objects, resemblances and differences; and the corporeal grounds of knowing and action" [14, p.3]. In design processes, the quality of relationality asks for three sensitivities: (i) understanding of mutual influence, shaping and co-constitution of actors and artefacts; (ii) embracing and supporting emergent and improvised action and (iii) consideration of the system as an assemblage/network of actors, artefacts or collective hybrids. In order to develop these sensitivities, we first need to stop formulating design solutions based

upon the assumption of a well-defined individual with fixed characteristics and capacities of action. Design solutions should recognize and support the existence of the multiple individuals embodied in one individual and the possibility of multiple enactments of one individual within a network of other human and non-human actors interacting with each other and exhibiting different capacities for action [11]. Rather than prescribe or control, we may design for appropriation and design-in-use, interactive systems do not impose a particular pattern of action; rather, they provide a space of negotiation in which individuals can exercise their "multiple" capacities of action in creative ways.

3.2 Visibility

Visibility, one of the most essential qualities, facilitates responsible design and the emergence of different arrangements or couplings between humans and technologies. The quality of visibility, which plays a key role in developing other sensitivities such as multiplicity and accountability in the design process, involves variously making visible invisible work, human and non-human actors, and infrastructure and interactions in both design and use of technologies. Visibility not only facilitates a heightening of the overall awareness of human actors of themselves and of others, but also helps the performance of more responsible design practices [9] [15] and discovery of new opportunities, constraints and matters of concern in design process [5].

Quality of visibility operates in both technology design and use. Visibility in technology design refers to recognizing every human and non-human actor and their roles in the formulation of design problem and the design process. This means that the different values, views and concerns of the human actors - and various affordances of non-human actors - need to be explicated and considered. Moreover, the term 'visibility in technology use' refers to keeping the boundaries and interactions between all humans and technologies distinct and observable. Seamful design [7] advocates the use of (beautiful) seams in interactive systems: seams can be basically gaps and breaks in functionality, and boundaries between different components or systems. Seamful design deliberately makes the seams visible and encourages system users to appropriate them as a resource for reflection and creative engagement.

3.3 Multiplicity

The quality of multiplicity refers to multiplicity in ways of knowing, performing and representing, which entail participation of multiple and heterogeneous sources of influence in the design process. Collaborative, generous and flexible methods and tools such as sketches, low-fi prototypes, rich pictures, and cartographic maps could prove useful in obtaining multiplicity in representation. These rich representations are particularly important vis-à-vis keeping the concerns of the different stakeholders or multiple sources of influence visible. While the design process can embrace multiplicity by supporting participatory, democratic and open practices together with rich representations of multiple partial forms of knowledge, design artefacts can embody multiplicity by utilizing flexible, context-sensitive and adaptive mechanisms.

3.4 Configurability

The design process does not stop after the technology production phase but continues in the actual use of technologies. In this broader view of design, the activity of design continues in the sites of technology use and is performed by users in the role of designers [10]. Aanestad describes this activity as 'design in use', a process which mainly involves continuous organization of activities and the re-configuration of relations between human and technological actors [10]. Users may opt to reconfigure or customize technologies and tune their relationships with technologies. The quality of configurability asks for developing mechanisms of supporting design in use or tuning operations during the use of technologies. This can be achieved by designing open, modular and flexible technologies. Kahle defines "openness of technology" as "the degree to which it empowers users to take action, making technology their own, rather than imposing its own foreign and inflexible requirements and constraints" [16, p.35]. The quality of configurability, inline with other qualities, supports variety in the formation of human capacity of action. By virtue of their modular and flexible structure, technologies may become less isolated and take part in a network or ecology of other technologies and humans [3] [11].

3.5 Accountability

The quality of accountability is applicable to both humans and technologies. Button and Dourish [17]

define accountability as the property of action being organised so as to be observable and reportable. Whereas accountability of technological systems entails the existence of accounts that systems provide users with information about their own activities [17], accountability of human actors requires them to be aware of their own position relative to other actors and taking responsibility for their own perspectives and partial knowledge [18]. The quality of accountability might be promoted by making visible the actors, roles, their locations and system accounts. However, an essential part of the designer's task is to provide other actors involved in the design with resources for increasing critical awareness of the notion of located accountability and its implications.

3.6 Duality

The quality of duality refers to consideration of the dual characteristics of design decisions. Van der Velden [9] maintains that technology is never neutral; neither in use nor in non-use. Dual characteristics of design decisions should be considered. Duality can manifest itself in many forms, e.g., privileging/ignoring, inviting/inhibiting and amplifying/diminishing. Our designs can privilege the values of some actors while ignoring the values of some other ones [15]. The inscription of values into technologies is inevitable. However, the problem is less about the inscription of particular kinds of values and more about the invisible, unquestioned and taken for granted values embedded in our thinking and practices. Parallel to the quality of visibility, values shaping our thinking and design decision should be made visible and open to negotiation. Moreover, the quality of duality involves consideration of both kinds of invited and inhibited actions and accounting for their implications.

4 Inscribing ASD Qualities

In our approach to developing ASD, we employed two important concepts of ANT: inscriptions and translations. We aimed to inscribe ASD qualities into design process and assess the capacities of the inscriptions to support ASD qualities in translation processes taking place in design activities. To this end, we conducted participatory design workshops consisting of various activities in which we employed at least one of the six ASD qualities in each session. The workshops were situated in an early exploratory

phase of design process, in which a consideration of relational view of agency can contribute more. In early phases of design, actors or stakeholders of a design problem are not aligned yet, and it is valuable to explore various ways in which these actors might be aligned. As designers usually aim to get a broader view of a design problem, reveal concerns of stakeholders, and explore the alternatives, ASD qualities with their emphasis on variety and multiplicity of agency might particularly prove useful for conducting exploratory activities in early phases of design. Therefore, we decided to situate our workshop in early phases of the design process. Participatory design workshops, with their emphasis on negotiation, diversity and co-construction of meaning, provided us with a suitable play platform. Muller explains the key characteristics of workshops as follows:

[W]orkshops usually introduce novel procedures that... take people outside of their familiar knowledges and activities, and must be negotiated and collectively defined by the participants. Workshops are thus a kind of hybrid or third space, in which diverse parties communicate in a mutuality of unfamiliarity, and must create shared knowledges and even the procedures for developing those shared knowledges [19, p.9].

We imagined a system utilizing full body interaction and ambient feedback. Full body interaction was selected because of its capacity to support a large variety of interactions between human body and machine compared to more conventional ways of interaction based on screen, mouse and keyboard. In order to not limit the ways of interacting with the system, we decided to not use a screen-based visual feedback, which may confine the range of interactions between body and screen. Instead, we preferred to use sound feedback, which provides more ambient feedback and does not limit the direction of body in space. In a very broad sense, the system will capture the movements of people, process it and provide some audio feedback. Two researchers with backgrounds in interaction design conducted three workshops each lasting approximately four hours. We worked with two female dancers, aged 22 and 23, in the first workshop, two female interaction designers, aged 22 and 23, in the second, one female and one male musician, aged 34 and 36, in the third. As our study involves design of human full body movements and audio feedback, dancers with expertise in movement

improvisation and choreography, musicians with their expertise in music improvisation and composition, and interaction designers with their expertise in bringing together different aspects of interactive systems provided us with a suitable set of participants. They allowed us to view the design problem from different angles and reveal different concerns about the system to be designed. The main theme of the workshops was connectedness, which is a suitable concept to explore various relations between humans and non-humans. There were four sessions involving exploratory activities: a silence session, a physical sensitivity session, a rich-poster session and finally a machine-mediated performance session. The activities in the sessions were selected according to their potential of supporting ASD qualities. However, the important point is less about this particular set of activities than about bringing together a diverse set of activities supporting ASD qualities and facilitating multiple ways of knowing, performing and relating. Thus, other kinds of activities can be added or some extant activities might be removed. What is important is to inscribe ASD qualities into the design process.

Our focus was upon the quality of multiplicity as the quality of multiplicity plays a key role in supporting the fundamental principle of ASD, but we also supported other qualities at varying degrees. The quality of multiplicity was inscribed in the entire workshop containing different kinds of activities and, as well, in roles, representations, and mediums. Each workshop session provided opportunities and resources for the participants to engage in the design concept in various ways. In addition, we, as researchers, tried to be as flexible as possible: this was important as it eschewed any possibility of subjecting multiplicity to obstacles. In addition to the multiplicity as an overall quality of the entire workshop, each workshop session embodied at least one of the six ASD qualities. The qualities of accountability and duality were not considered at this stage. We conducted a pilot workshop and found that the accountability was not very relevant in such exploratory design activities and considering the duality at this stage complicated the workshop activities. In the silence session, participants are asked to close their eyes, concentrate on and listen to the existence of their own and their partner's body and space. They are also asked to sit down on the floor in a back-to-back position. This session facilitates a connection between

participants through silence and breaks the dominance of vision as a main modality of connecting with other entities. In the silence activity, we aim to inscribe the quality of visibility by increasing the sensations of other modes of perception.

In the physical sensitivity session, participants perform physical exercises encouraging interaction through body movements. There are three short activities in the session; in the first, one of the participants was asked to touch the crown of her partner's head and lead her to and fro using pressure changes. The two are asked to keep the contact between hand and crown. In the second activity, the participants change roles, then pursue the same activity. In the third, they are asked to simultaneously touch each other's crown and to repeat the same to and fro movement. The first activity is called palm-crown exchange, the second, reverse palm-crown exchange, and the third, simultaneous palm-crown exchange. This activity enables participants to create a touch-based connection between two bodies and experience giving and receiving roles in a human-human connection. In the physical sensitivity session, we aim to inscribe the quality of relationality by introducing a physical touch-based exercise in which the sensations and movements of one body is tightly coupled with another.

In the rich-poster session, the participants make a collage of pictures provided on a sheet of A0-paper, then annotate them according to the particular kind of connection that each represents. In addition, participants talk about three objects that they felt a connection. In rich poster session, we aimed to inscribe the quality of multiplicity and visibility by making visible the various forms of connections illustrated by participants' selection of pictures and their annotations. In the final machine-mediated performance session, participants perform five short activities using three technological devices: two wearable devices - one with tilt and another with distance sensing capabilities - and one webcam with motion sensing capability. The task of participants is to explore different forms of connection with other bodies through technologies that allowed participants to create various sound effects through their body movements. In other words, they are invited to improvise movements and sounds by using different technological devices. When needed, we provide additional instructions for participants, which could guide their performance. These instructions

include selecting a theme for activity or using some constraints on movements such as making slow/fast movements or being mobile/stationary in space. In this session, we aim to inscribe the quality of multiplicity and configurability by providing participants with three technological devices enabling three different ways of coupling between human, technology, and space, and various straps that allow them to attach the devices to any parts of their bodies. Tilt devices generate sound effects based on movement in vertical and horizontal dimensions: the rangefinder devices produce sounds based on the changes in the distance within a 70cm range. Finally, the webcam detects motion and triggers musical notes according to the place of motion in space. While the Wii-motes and the range-finder devices need to be attached to the body, the webcam can be placed somewhere in the space detached from the bodies. The multiplicity in capacities of technological tools and ways of coupling with the technologies allow participants to explore and perform various connections through their movements and sound effects.

5 Analysis Methodology

We identified some indicators that show the effectiveness of session inscriptions on supporting the

Session	ASD Quality	Indicators for Effectiveness
Silence Session	Visibility	<ul style="list-style-type: none"> • Amplified sensation of other modalities • Emergence of any kinds of connections through amplified modes of sensation • Appearance of previously invisible actors
Physical Sensitivity Session	Relationality	<ul style="list-style-type: none"> • Following the inscription of keeping the contact and maintaining the roles • Comments of participants on the mutual nature of connection, strategies of coordination, and reciprocity • Smooth coordination of movements
Rich Poster Session	Multiplicity, Visibility	<ul style="list-style-type: none"> • Variety in the themes of pictures and related associations. • Manifestation of different personal understandings of connection • Emergence of new connections
Machine-Mediated Performance Session	Configurability, Multiplicity	<ul style="list-style-type: none"> • Variety in ways in which humans and technological devices are coupled • Variety in ways in which humans connect with other humans and environment through technological devices

Table 1. Indicators for effectiveness of session inscriptions in supporting ASD qualities.

relevant ASD qualities (Table 1). These indicators were translated to the context of the design activity from the original definition of each ASD quality after watching all video sequences and reading all the transcriptions.

Our analysis is based on our in-situ notes, interview transcriptions, video sequences and posters. In the final session, we developed an extended version of Laban's [20] effort categories to characterise the different forms of movement-based connections. Laban's effort categories are useful for describing the temporal and dynamic qualities of human movement. There are four categories, each of which has two polar values: i) Space: Direct/Indirect; ii) Weight: Strong/Light; iii) Time: Sudden/Sustained; and (iv) Flow: Bound/Free. 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 three 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 three or more seconds. We analysed video segments by using a coding scheme, which included nine 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. When coding the segments, we also consulted our transcriptions of the reflection sessions of activities.

6 Results

In this section, we present the results of the first three sessions briefly and allocate more space to results of the final machine-mediated session in which we observed large differences between the workshops. In the next sections, we usually refer to workshop participants according to their area of profession as dancers, interaction designers and musicians. Our aim is not to make generalized claims on professions or casual connections between professions and the workshop outcomes; rather, it is just a convenient way we chose to refer to the participants of three workshops.

6.1 Silence Session

In fact, the silence session was not designed to be a fully featured session like the other three sessions in which we tested the effectiveness of our inscriptions to support the related ASD quality: it was more like a prelude session preparing participants for the following more demanding activities. Our inscriptions simply aimed to support the visibility of other modes of perception. According to participants, the temperature of their partners' body was the most dominant sensation. The participants stated that they also noticed the sound of air conditioner, noises from outside and the sound of their watch. The participants said that they did not feel any strong connection with their partners. The temperature of bodies and previously insensible sounds were new actors that emerged out of the activity. The participants sensed the previously insensible things in the space. However, they were not able to create connections through the amplified modes of sensations.

6.2 Physical Sensitivity Session

Dancers and musicians performed the activities in a similar way. They maintained the contact between palm and crown during all three exercises and demonstrated a very fine control of their movements. They were also very attentive to the leader and receiver roles assigned to them. In contrast, interaction designers were not able to coordinate their movements smoothly and frequently lost their connection. Their movements were usually very fast and sudden. While the comments of dancers and musicians described the subtleties of the connection: "to what degree I'm sure that we are connected or not?... It doesn't feel like it is organic, particularly in the simultaneous giving-receiving one"; "There are lots of questions around to what degree to keep a straight line"; "it was not until I was receiving I really understood how it was to be at the other side of the conversation... I realized that I didn't have to push... a little touch was sufficient to give a signal and initiate the movement", the interaction designers' comments described more like a playful exploration: "To see how far she can go! It was funny... It was just to see what happens, and she jumped. It was like she was a toy-puppet"; "I was pre-determining what she was going to do". All participants developed some strategies to explore the dynamics of the connection such as making the movements at the same/opposite direction or in different speeds.

6.3 Rich Poster Session

The objects that participants brought to the workshop included books, pictures, drawings, quotes, a compass, a pebble and a CD cover. The objects revealed many different types of connections: connection as a memento, connection as a feeling of absence, connection as a shared interest, and connection as transformation. The objects enabled participants to make visible their personal understandings of what makes a connection significant for them. Dancers and interaction designers created similar posters involving various pictures and themes. The diversity in the kinds of images facilitated the participants to share many stories and reflect on them. In contrast to the posters in the previous workshops, musicians' poster did not demonstrate a large variety in the selected images and associated connections. There were no stories or experiences accompanying the images. The selected images were either abstract patterns or images as colourful geometric shapes. Their meanings were abstracted away. In fact, in the final poster, collage of all the pictures represented a single manifestation of a visually balanced composition.

6.4 Machine-Mediated Performance Session

In this session, we needed to revise the software algorithm mapping movements to sound effects after the first workshop in which dancer participants could not complete all five activities because of the complexity of the mapping algorithm. In the first workshop, the tilt and rangefinder devices were coupled. 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. The reason of using coupled devices was to evaluate whether a preset coupling between devices facilitates more collaboration and creative engagements between participants. However, the participants in Workshop 1 found the control of the coupled devices complex and felt frustrated and could not complete the session. Thus, for the workshops 2 and 3, we decided to have two versions of the devices: coupled and decoupled. 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 and participants have total control over the creation of sound effects.

Table 2 shows the number of connections constructed in each workshop session using coupled devices, decoupled devices and a webcam.

	D-Tilt	C-Tilt	D-Range-finder	C-Range-finder	Webcam
Workshop 1	N/A	5	N/A	N/A	5
Workshop 2	7	3	14	4	12
Workshop 3	6	4	10	2	5

Table 2. Number of connections in each workshop using five devices: D-Tilt (Decoupled-Tilt device), C-Tilt (Coupled-Tilt device), D-Rangefinder (Decoupled-Rangefinder device), C-Rangefinder (Coupled-Rangefinder device) and Webcam.

Workshop 1. In this session, the participants were only able to perform the first two activities and could not complete the session because of some perceived technological deficiencies. The participants considered the devices incapable of doing what they were supposed to do. In the first activity, the camera did not capture one participant's large movements as required, and the sound effects seemed to be arbitrary. Therefore, the participant could not understand the relation between the sound feedback and her movements. As a result, the participant got frustrated because of not being able to get the feedback properly. In this activity, connections were created through movements rather than sound. The participants employed strategies of stopping, making similar movements and varying the tactile sensation to create connections. In the second activity using coupled tilt devices, the participants found the mapping between the sound and movements complicated, and again, they felt frustrated. Thus, we decided to stop the activities and continued with the participants' reflections and suggestions. In the next workshops, participants used decoupled tilt devices, coupled tilt devices, decoupled rangefinders, coupled rangefinders and webcam respectively.

Workshop 2. While the highest number of connections, 14, was observed in the third activity using decoupled rangefinders, the lowest number of connections, three, was in the second activity using coupled tilt devices. Although there was a large variety in human-human and human-space couplings through technological

devices, individual human-device couplings did not demonstrate such variety. Participants preferred to use their devices with their hands although it was possible to attach them to many parts of body. They did not use the straps provided to them. Therefore, we observed a single form of coupling, device-at-hand. However, in the case of webcam, we observed a large variety in human-device couplings as well: participants performed ten connections by variously using their arms, hands, legs, torso or full body to create sound effects. The participants preferred to express some themes or phenomena that they decided upon at the beginning of the activities when using the range-finder devices and the Wii-motes. When using the camera, however, they chose to make free movements and express their emergent ideas and feelings.

Workshop 3. Similar to the previous workshop, the highest number of connections, ten, occurred in the third activity using decoupled range finders. Different from the previous one, the lowest number of connections, two, was observed in the fourth activity using coupled range finders. Again, participants did not use straps and hold the devices with their hands. Apart from the activity using a webcam, participants only used their hands and arms to create sound effects. Similar to the previous workshop, only the device-at-hand coupling was observed. Participants' bodies were stationary in space and facing each other all the time. Although they used their full bodies in the final activity with the webcam, they could create five connections. Different from the other workshops, they developed a vocabulary of expression involving various movement-sound pairs. When they discovered a good movement-sound pair, they included it into their vocabulary and then, used it again later to compose melodies in the activity. However, this was not the case for the interaction designers, who tried to find as many interesting movement-sound pairs as possible.

7 Discussion

7.1 On Visibility

We aimed to support visibility in silence and poster sessions. In silence session, our aim was to increase the visibility of other modes of sensation. This was achieved according to the participants' statements. The participants sensed the previously insensible things in the space: the temperature of another body, sound

of watch and A/C. However, in order to be able to create connections through these different modalities, more time is needed. In the poster session, our aim was to make visible the various forms of connections between humans and other entities. Apart from the third workshop in which the poster was a single manifestation of visual aesthetics, the posters in the first two workshops exhibited various forms of connections like connection as memories, criticism and culture.

7.2 On Relationality

We aimed to increase participants' awareness of relationality of their capacities for action. The three exercises in physical sensitivity session were scripted activities amplifying the sensation of reciprocity of our actions through sensing the effects of our movements both visually and in a tactile way. The proximity of the bodies amplified the sensation. The exercises were extreme cases of connectedness where one body was strongly connected to another in a physical way. The sensations and movements of one body were tightly coupled with another. There was a very high degree of influence between the bodies, which increased the visibility of the relationality of our bodies. In all three workshops, participants' comments demonstrated sensitiveness to the shared capacity of their actions and co-construction of their performance. Apart from the second workshop in which the participants lost their connection frequently, the exercises, in general, were effective in emphasizing the quality of relationality.

7.3 On Multiplicity

We aimed to support multiple ways of engaging with the design concept, multiple roles for, and multiple mediums of expression.

Multiple ways of engaging with design concept: Different kinds of activities allowed us to understand different forms and dimensions of the design concept. In general, rich poster and machine-mediated performance sessions were effective in producing various forms of connections. Many different forms of connections were revealed: connection as movement, connection as sound, connection as criticism, connection as memories and so on. Many different strategies to construct and maintain connections were observed: making similar movements, making opposite movements, combining stops and repetitive movements, combining stops and varying movements and a-synching movements.

However, our inscriptions could not achieve their goal in the rich poster session with musicians and the machine-mediated performance session with dancers. While the musicians preferred to create a single visual form of expression, the dancers found the technology insensitive to perform together and could not complete all activities in the session.

Multiple roles. In the Physical Sensitivity Session, the participant performed the same activity by switching the roles of leader and receiver. It was effective in enabling participants to develop a relational understanding of their movements. Therefore, the quality of multiplicity served to support the quality of relationality.

Multiple mediums of expression. The participants used different mediums such as paper and technological devices for expression. For example, the rich poster session allowed the participants to express their views of the design concept on a 2D shared medium, i.e., on paper, in the form of a collage of pictures and texts. They created representations or proxies of the previous connections they had made in their lives. In addition, the totality of pictures and texts revealed forgotten or unknown connections between places, people and memories. Moreover, each technological device invited different patterns of action through different levels of connectivity. The connectivity can be defined as an entity's ability to make connections. The webcam and rangefinders with their high degrees of connectivity facilitated the creation of many different connections whereas the tilt devices with the low degrees of connectivity could only support the construction of a few connections.

Although we advocate the inclusion of multiplicity as a quality in design, there might be some undesired effects of multiplicity on the design process. One participant from the first workshop vocalized her concern about engaging with multiple activities and multiple media in the activities:

Ultimately, we are transferring, transferring and transferring through different media. But, in that transference, we are getting further and further away from proximity to actual sensitivity and composition.

This is an important criticism on using multiple activities and multiple mediums in a single half-day workshop.

The participants could only spend short periods of time in each activity, and this limited participants' capacity to obtain a deeper understanding about each of their relations with other participants, materials, and technologies. Multiple activities might enable researchers and designers to get a broader perspective on many dimensions of a design concept or problem, but the knowledge obtained from these short-lasting activities might be imprecise, shallow and scattered. This might be a disadvantage for design projects with a more specific focus. However, it might be advantageous for the design projects at an early explorative stage in which getting a broader perspective on many dimensions of a design concept or problem is very valuable.

7.4 On Configurability

We aimed to support configurability by making wearable devices compact and portable. They were attachable to different parts of the body by using various straps. However, the participants did not use the straps and hold the devices with their hands. The inscriptions of straps involving the quality of configurability were not translated in the practice in the expected ways as the particular characteristics of sensing technology and mapping algorithm, i.e. their inscriptions did not invite use of many possible configurations between human body and the wearable devices. The lack of expressive capacity in many of the configurations rendered those configurations useless or not preferable. Here, configuring the ways in which the device and the human body are coupled became less desirable for the participants since a particular configuration, tilt-at-hand, provided participants with the opportunity to exploit the expressive capacity of the device at maximum. The six qualities introduced here are a starting point towards developing ASD. Our aim is not to replace existing design approaches but rather to complement them by relativising how we think and go about design. What is needed is not to take these qualities as prescriptions or strict guidelines for action but to use them as lenses through which to see design problems and processes from a relational point of view.

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Baki Kocaballi¹,

Petra Gemeinboeck²,

Rob Saunders¹,

Lian Loke³,

Andy Dong¹

¹The University of

Sydney; ²University

of New South Wales;

³University of

Technology Sydney