Expanding Affective Computing Paradigms Through Animistic Design Principles

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Abstract. Animistic and anthropomorphic principles have long been investigated along with affective computing in both HCI and HRI research, to reduce user frustration and create more emotive yet relatable devices, robots, products and artefacts. Yet such artefacts and research have mainly been from user-centric perspectives and the animistic characteristics localised to single objects. In this exploratory paper, we take these principles in a new direction by attempting to invoke animistic characteristics of a room or a space itself. Designing primarily for space itself rather than the user or a single product, allows us to create new interactions and narratives that can induce animism and empathy for the space, in users. This leads to the creation of a prototype space, which we use to investigate how users approach, interact and behave in such a space, yielding several insights and user behaviour, all of which can be used for further studies, capable of generating new interaction perspectives and providing insights into user behaviour. We conclude by discussing the potentiality of such spaces in developing new strategies for behaviour change and HCI.

Keywords: Animism · Spatial interaction · Empathy · HRI

1 Introduction

Affective computing has resulted in computers and devices being sensitive to the emotions and moods of the user. Driven by the initial need to reduce user frustration, research into the field has resulted in several bodies of work that have enabled new, natural and intuitive interactions and experiences in both Human Computer Interaction (HCI) and Human Robot Interaction (HRI) [4].

Emotional design has explored how emotional experiences can be stimulated in users through careful product design [5]. Research has long sought after creating products that elicit positive emotional experiences in users. Going a step further, the fields of HRI and Ubiquitous Computing (Ubicomp) [43] have long utilised and investigated the principles of anthropomorphism (the attribution of human-like characteristics to non-human entities) and animism (the attribution of life-like characteristics to non living entities) to create robots and artefacts

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that are more relatable to users and to try to achieve user empathy and bonding with the artefacts and robots [25]. Entities such as voice assistants are becoming more human-like, for users to relate to them better and be able to use them easier. Norman's Three Levels of Emotional Design have been used for creating a variety of products that we have in our homes today [5] and with the advent of the Internet of Things, these products now have additional functionalities and capabilities that offer new paradigms of interactions with them. Our homes and environments are becoming increasingly filled with such inter-connected and internet-connected devices that seek to become more 'human' to better relate to the user [26].

However, all these products and research focus on the creation of entities that try to achieve user needs and goals. This potentially limits the interactions and possibilities that can be explored. What if the status quo was flipped and the products themselves had needs, moods and requirements that the users must be sensitive to? Could we draw out new experiences, interactions and paradigms from such products/entities? Could users empathise or even form emotional bonds with such products/entities? Research supports the notion of a user forming intimate bonds with technological artefacts and products [27] and new research directions such as Thing-centered Design (TCD) investigates the potentiality of designing from the perspective of the artefact/product being designed, as opposed to the user; i.e. a 'thing-centric' over a 'user-centric' approach [18].

Expanding this perspective, what if instead of creating stand-alone products, designers utilised many such artefacts, that in unison, provide a larger entity such as a room, a park, or any space, with animistic and experiential characteristics? How would users of such spaces behave with them and within them? How differently would they interact with them, if they began to feel that the spaces were 'alive'? Would they be able to empathise or form bonds with the spaces themselves? Could such bonds/interactions be used to achieve secondary goals?

That is what we attempt to investigate with this line of research,exploring further the paradigm of affective systems by creating systems and devices that evoke and stimulate empathy in users for the system itself, rather than systems that simulate empathy. This exploratory study and corresponding paper are part of an ongoing investigation into whether empathy can be stimulated in users for an entity such as a space and how users will behave towards, and in, such spaces. In this first part of the study, we ask how such a space can be created and what are the main takeaways and observations from users interacting with the space? To do so, we first interviewed potential users from various backgrounds to probe them for impressions about the idea of such a space. This allowed us to uncover limits, boundaries and principles with which to create a prototype space, using various connected sensor and actuator artefacts. These interconnected artefacts, in unison, along with the animistic narrative that they were the 'sense organs' of the space, allow the space to be 'alive'. Additionally, we also designed interactions for the spaces that gave it a certain level of autonomy and playfulness; all contributing to the above narrative. This prototype space enabled us to monitor

and probe user behaviour and interactions in and with it, which brought out interesting insights that can be used to develop the space further and to design new interactions. The intention is to use such spaces for future studies regarding behaviour change and interaction design.

2 Related Work

There are several areas and domains that this paper touches upon, ranging from affective computing, enhancing emotional user experiences, anthropomorphic and animistic design, to the intermingling of physical and digital spaces in the form of blended spaces.

The idea of merging emotions with computing devices comes from Rosalind Picard's original concept of affective computing, which arose as a means to both reduce user frustration and improve user experiences through the communication and processing of user emotions [4]. Bickmore and Picard state that when a product sympathises with users, it increases the users' appreciation of the product and the product's lifespan [28]. This has led to the development of technological systems that can react to user emotions by detecting emotional cues such as voice tone, facial expressions, etc. [29]. Corresponding research in HRI the communication of emotions has led to the development of robots that are capable of mimicking facial expressions [30]. In the field of product design, Norman's emotional design attempts to elicit positive emotions in users through careful choices about how a product looks, feels and functions. However, this line of research does not explore the opposite, a perspective that attempts to make computing devices or products more likeable, endearing and intimate, to enhance emotional user experiences and also open up new design spaces, although there are other studies that support the concept that users can form intimate bonds with technological products [27].

Animism, the attribution of life-like characteristics to non living entities, and anthropomorphism, the attribution of human-like characteristics to non-human entities, have long been investigated in both anthropology and psychology. Understanding that humans tend to ascribe life-like or human-like characteristics to non-living and non-human entities to make sense of the world, indicates that this is almost primal and basic [3], as opposed to abnormal behaviour. Airenti postulates that anthropomorphism and animism are grounded in interaction rather than any specific belief system [1]. This makes it of particular interest to interaction designers. Animistic and anthropomorphic entities are more relatable to users and therefore, easier to form bonds with. Early design research explored the metaphor of living things to enact intimate intelligent design, as exemplified by the Clippy and other assistants created by Microsoft [40].

Various research has been conducted on using animistic and anthropomorphic principles to make artefacts that are endearing and intimate with users. Work done by van Allen, et al. explores animism as a methodological framework in interaction design through multiple design artefacts (AniThings) [17]. CAMY is a ubicomp product, designed using animistic and zoomorphic (attributing

animal characteristics to non-animal entities) principles to investigate the effect of pet-like characteristics on users emotional experiences, specifically intimacy and sympathy [25]. CAMY is a specific example of how animism can be used to improve and enhance the user experience. The work presented in this paper is in line with, and inspired by, these works. However, they are focused on the creation of localised products that exhibit animistic characteristics. This study attempts to expand and extend these characteristics to the environment or space within which such artefacts or products are placed.

In the era of ubiquitous computing, our environments and living spaces are increasingly being imbued with various sensing and computing devices, granting them new capabilities [35,37], particularly with the advent of the Internet of Things. This provides a new design space, rife with opportunities to explore. The notion of extending physical spaces into the digital world can be seen in Blended Spaces, which seeks to merge physical and virtual worlds, in a kind of symbiosis [13,14].

Borgmann defines objects and entities in two categories - Commodities, which are objects having no significant value apart from their principal function and Things, which are objects that have emotional values and meaning associated with it, in addition to their functionality [6]. From this perspective, all previous research relating to emotional design and animism have been centred around turning products from commodities to things. This paper explores how the emotional value and meaning of any space, public or private, can be enhanced through the animism provided by artefacts that exist within them, such that more people will consider them as Things.

Nam et al. in their Design by Tangible Stories method present that having a compelling narrative and adding experiential values to an entity, greatly enhances its propensity to be given animistic characteristics by users [7]. They also state that new design opportunities are found by focusing on 'ludic' or playful values while applying new technologies to everyday products of home environments. This paper expands on this concept by treating the home environment or space itself as the entity to be given a compelling narrative and experiential value. Huizinga [8] explains that people are characterised by play as much as they are by thought or tool use, making playfulness an animistic quality. Thus applying such an animistic quality on a space would both enhance its experiential value, in addition to potentially revealing new forms of interaction between users and the space. Our environments and spaces provide us with both a location and the mechanisms to indulge in ludic activities, yet we do not engage with a space itself as we do with other living beings. If a space were to interact with us in more playful ways, it could potentially change users' relationships with them and bring out new interactions and behaviour. This forms the basis for some of the interaction choices made in this study.

However, animistic and anthropomorphic artefacts are particularly susceptible to the 'uncanny valley' effect [12], wherein a non-human entity behaving akin to a human triggers discomfort and sometimes even fear in users, due to cognitive dissonance. Thus, as designers we must embrace a fine line between what

triggers empathy and what triggers fear. Pursuing the drawbacks of animism and anthropomorphism, lead us to the contrasting views regarding the role of anthropomorphism in HCI. Shneiderman [33] embraces an extreme view of this by asserting that employing anthropomorphism in HCI compromises the design, leading to vagueness and unpredictability. He advocates for predictable and comprehensible interfaces that support direct manipulation instead. However, Duffy [16] presents a counter-argument to this by asserting that Shneiderman's comments are not problems relating fundamentally to anthropomorphism, but rather correlating to HCI designers indiscriminately applying certain anthropomorphic qualities to their designs without understanding users' tendencies to anthropomorphize. He also states that Shneiderman's arguments are valid when the system to be designed, is intended as a tool. Since this study intentionally aims to mean the system as something more than a tool, this study is in line with Duffy's counter-argument.

Nass and Moon [29] present experiments through which they show that individuals "mindlessly apply social rules and expectations to computers" but are contradictorily against anthropomorphism as they believe that computers are not people and therefore do not warrant human treatment. Duffy [16] states that the problem here is with portraying lifeless machines and computers as having human-like qualities. The broader psychological perspective of anthropomorphism, which includes metaphorically ascribing human-like characteristics to a system based on the user's interpretation of its actions, is different. While this study does indeed try to portray an inanimate entity with anthropomorphic qualities, it does so by basing this in users' tendencies to anthropomorphize. By including users in the design process, through the initial interviews, the circumstances under which users tend to anthropomorphize are brought out.

3 Method

Since the notion of self-aware computing devices has a lot of prejudices and triggers fear in users, we sought to include the users in as many stages of the study as possible. We conducted the study in three stages, starting with interviews with participants to understand how they relate to their environment and possessions, as well as their impressions on the idea of a 'living space'. These formed a foundation for the prototyping stage that followed, in which various artefacts were built and installed into the chosen space, which was given a narrative of being alive. Finally, we evaluated the prototype space so created, with a focus group of participants who had a discussion within the space, while it interacted with and reacted to them.

3.1 Participants

10 participants (3 female, 7 male) participated in the initial interviews. The initial participants were acquaintances of the first author who referred subsequent participants for the interview. Participants ranged in age from 23 to 63 (M =

38.0, SD = 14.38). This selection of users is, by no means, an 'indicative' group of potential users but rather a snowball sample to identify trends and patterns.

For the focus group, 6 participants (2 female, 4 male) were recruited by the first author from their acquaintances. Participants ranged in age from 24 to 29 (M = 27.5, SD = 1.87). These participants were not included in the initial interviews.

3.2 Procedure

The interview study used a variety of communication tools such as Zoom, FaceTime, and WhatsApp to remotely conduct the interviews. Each interview lasted approximately 45–50 min and was recorded, after asking the participant for consent. Most interviews were conducted in English and relevant quotes were otherwise translated to English. Otter.ai[1], an automatic transcription service, was used to help with the transcription of recorded interviews. The interviewer created and followed an interview guide while conducting the interviews. The interview questions were grouped into various sections and were aimed at probing how the participant related to various entities in their lives, from plants and pets to technology, heirlooms, houses and homes. They also probed the participants reactions to the idea of a animistic space or entity, by posing it as a series of hypothetical questions. Participant comments were coded using initial coding [42] by a single coder. Statements were assigned emergent codes over repeated cycles. A thematic analysis [39] of the codes were then done, identify patterns and trends of note.

After the interviews, prototyping followed, where the Design by Tangible Stories method [7] was used to create narratives for the artefacts created in the prototyping phase. In this context, we define an artefact as a prototype object designed and created by the designers. Technical design and prototyping were done by the first author, in line with agile principles with the goal being to have working, proof-of-concept prototypes at the end of each sprint, followed by testing these artefacts through roleplay. Various interactions were created using the artefacts.

The artefacts were then given the narrative that they were the instruments through which the space experienced events that occurred within it. These were then deployed in a lab space, thereby resulting in the creation of the prototype space, which was then evaluated through the focus group of six users.

The participants of the focus group were not told about the nature and topic of the focus group beforehand, so as to avoid any sort of bias. At the venue, they were told that they were presented with the following narrative:- The participants would be engaging in a focus group discussion in a space that was imbued with technologies that enabled it to be 'alive' in a sense. They were told that the space would also be participating in the discussion as the final member of the group. The creators of the space had created it in such a way that they themselves had no idea or answers as to why the space would choose

[1] https://otter.ai.

to behave in certain ways. The space was given certain experiential qualities and a 'personality' and would react to the events that occurred within it and in accordance with its 'personality'. Whenever the space reacted or behaved in accordance to a stimulus or a random event, participants were encouraged to come up with their own theories as to why the space chose to do so. The participants were not told about what interactions the space could or would do but were encouraged to discover them serendipitously. They were also allowed and encouraged to freely move about the space and interact with anything that they found interesting. The interviewer followed a guide for the discussion but broke away from the script, if they deemed anything interesting was transpiring between the space and the users.

4 Results

4.1 Interview Results

The initial interviews with participants generated after thematic analysis, a set of design recommendations. These recommendations are given below in **bold**. *Citations* of the participants are presented together with an identifier Pn, where n is a number that represents each participant.

Anthropomorphic agents should be non-threatening
Presenting hypothetical scenarios where a robot/computer agent was considered as intelligent as a human, triggered discomfort and even fear in most participants, who were wary of having such entities in their homes as exemplified by the following quote -

"I would be frightened if I was in a position where I assigned the same aliveness to a robot or an Alexa that I assigned to you and even more uncomfortable having it in my house." - P3

Mainstream media portrayal of Artificial Intelligence as the "end of the human race" tends to bias users towards the idea of intelligent robots and AI [2]. However, when presented with a video of Cozmo [41], participants were far more receptive and open towards interacting with it and having it around their homes. They did not consider the robot as intelligent as a human and regarded it as a toy, reflecting its ludic nature and perceived level of intelligence. These indicate that having ludic values and interactions helps soften human prejudice towards anthropomorphic agents.

Occasional randomness and out of the ordinary behaviour instigates curiosity and animistic tendencies in users.
Participants with pets mentioned that they felt curious or concerned when their pets behaved differently. They were able to learn more and understand their pets better when they were able to trace the behaviour to an event or situation. They felt such behaviour and communication made their pets feel more human. Drawing upon this parallel to human-pet interactions, designers designing for anthropomorphism can strive to add occasional randomness and ambiguity in agent behaviour to induce curiosity in users [25]. Enabling users to link the cause

for the 'out of the ordinary behavior' to associated events, additionally serves as a channel for the agent to obliquely interact with users.

Reward for positive interactions and conversely punishment for adverse interactions with the agent induces animism in users. Inquiries drawing upon human-plant and human-pet interactions revealed that users felt rewarded and joyful when their pets or plants responded positively to their care. Conversely, users also felt guilty when the plants and pets reacted negatively to neglect or adverse interactions. For example, users felt joyful when plants bloomed under their care and guilty when plants withered due to inattention. Participants considered this to be an essential trait of living beings.

"I would hate to have a dying plant in my house. Somehow, I would try to revive it because I feel responsible for it. I would try all sorts of things, before discarding the plant, to see one tiny new leaf coming out. It gives such happiness." - P4

Positive and negative interactions from users should elicit appropriate responses from the agent; taking care of, or interacting with the agent ought to make the user feel rewarded while neglecting it ought to make them guilty.

"It could be silly, but there is a wooden swing in my apartment that I am somewhat attached to, and I feel that it misses me when I'm not there. When I think of home when I'm traveling, along with my family, possibly more than my family, I start thinking of this swing whenever I feel nostalgic." - P4

The above statement, in particular, is an example of an opportunity interaction designers can utilize for inducing animism. For example, designing feedback that manifests the swing's joy upon interaction and its sorrow upon being neglected for prolonged periods, can considerably increase the animistic quality of the swing.

Anthropomorphic agents must indicate privacy palpably and must consistently uphold user trust concerning privacy-related matters. While technically not in the same domain as anthropomorphism, privacy is of significant concern to users. A majority of the users indicated that they were worried whether an anthropomorphic agent would monitor their behaviour and share private data without their consent or that somebody else would be able to control or manipulate the agent and cause them harm. Such fears are justified as there have been numerous cases where services and products obtained and shared private data without user consent.

"I would be more comfortable with interacting more with Alexa/Siri and the idea of a more intelligent Alexa/Siri if it was just between me and Alexa/Siri. If I know for sure that there is no way anybody else can manipulate the software or the artificial intelligence or the controls of the artificial intelligence, except me." - P3

Privacy concerns influence user trust in agents and therefore are significantly important when designing those agents and interactions. Drawing upon parallels with human-pet and human-plant interactions again, users felt comfortable sharing secrets with plants and pets because they knew that those plants and pets were physically incapable of revealing those secrets. Similarly, in human-human

interactions, users would only reveal secrets to people who earned their trust. Thus, user trust is a quality that interaction designers need to assume as unearned.

Since no amount of assurance can ever fully allay user suspicion and fears, palpably indicating that agents either are incapable of sharing private data or cannot share it without user permission, is a means to start earning user trust. Agents must then strive to gradually gain user trust by consistently assuring and proving to their users that private data was not shared (at least not without permission). In cases of breached trust, the agent must strive to be contrite, to regain user trust.

Agents should invoke familiarity and security in users.
When questioned explicitly about objects that they tended to anthropomorphize, several users mentioned various things in their homes that they felt connected to and had a 'personality' of its own. These things varied (ranging from bicycles and cars to swings and guitars) and were given different levels of anthropomorphic qualities (names and quirks to moods and entire personalities). However, they all shared commonalities: they were all objects that users interacted with regularly and had shared experiences with, which is why the users felt attached to the object. They invoked a sense of comfort and familiarity among users.

Therefore, when designing anthropomorphic interactions and characteristics for agents, familiarity and affordances must be maintained. While this is true for interaction design and user experience in general, it is of particular importance to anthropomorphism and animism.

Use the functional and practical values of animistic and anthropomorphic agents to induce users to try them.
In the interviews, hypothetical scenarios relating to autonomous, animistic, and anthropomorphic environments were presented to participants to probe their receptivity to the concept. Most participants were enthusiastic or at least cautiously optimistic and open to the idea of a living house that can take care of itself and interact with them on a more personal level as evidenced by the following quotes -

"I would totally be open to the idea of a house that was capable of taking care of itself. That's where it is going anyways." - P3

"From the utilitarian perspective like it's definitely useful, like a smart house basically. I mean, we've already got a couple of those things in our home. So long as these things like security are tightly regulated." - P6

"I think if the house was entirely automated, I do not think I would feel very involved in it. If the house still required me to be involved in it, I think I would definitely be inclined to do so." - P7

In some cases, the participants were not optimistic about the idea, as seen in the following quote -

"I don't think such a house would make me feel good, because what I make about my room is what I do to it or, like what I inflict in it. I like to clean or take care of it." - P4

Some participants were even able to see new potential uses for such an entity, such as taking care of their pets when they are not at home. From such data, we can deduce that the functional and practical value of a living home appeals to users the most. Pragmatic features are necessary for the initial investment of time and attention from users in animistic or anthropomorphic agents, while subsequent investments require ludic qualities. Thus, applying a blend of anthropocentric and thing-centric design methodologies is essential to the design of animistic and anthropomorphic entities. Designing interactions and features from both perspectives can result in the creation of truly memorable experiences.

4.2 Prototyping Results

The prototyping phase resulted in the creation of several sensors and actuator artefacts which were deployed in a public lab space at a Swedish university. A narrative envisioning the space as an entity limited in its intelligence and capabilities, but still having experiential qualities, was chosen. The above created sensors were embedded into the space, to form the 'senses' and actuators the interactive 'appendages' of the space, similar to their organic counterparts in living beings. These sensor artefacts granted experiential qualities to the space, by functioning as the instruments through which the space experienced events occurring within in it and the actuator artefacts served as instruments and ways for the space to express itself and communicate with users.

The sensor and actuator artefacts developed during prototyping were both inspired by and drew parallels to many organic systems, such as eyes, skin, mouths, etc. etera, leading to an expansion of the narrative for development. Taking cues from Biomimetics, i.e. the imitation of the models, systems, and elements of nature to solve complex human problems [21,22], it was possible to view the whole system as a metaphorical 'homunculus', with each artefact or subsystem communicating and co-operating, akin to how various organ systems in the human body communicate and co-operate. This anthropomorphic perspective in the design process itself can aid designers and developers in visualizing an abstract entity such as an anthropomorphic space and its subsystems. It also serves as a source of inspiration, making it easier to develop more artefacts and subsystems. However, the homunculus narrative is not presented to users and inhabitants of the space to avoid triggering fear and prejudice.

The narrative for inhabitants instead encourages them to view and treat the space akin to a young pet or being that is just learning to understand the world, in its way. A simplistic way to describe the system is - *"What if your room was a Tamagotchi (the digital pet)?"*.

The space utilizes multiple modalities of interaction to communicate with its inhabitants. Familiarity, inconspicuousness, serendipity, naturalness formed the cornerstones for designing the interfaces and their interactions. Objects and artefacts that are likely to be found in the space served as the basis for the interfaces. The technological aspects of these interfaces were kept as hidden as possible, to avoid prejudicing the inhabitants towards treating the object as a commodity. The emphasis is upon natural physical interaction with natural materials. This was

deliberately done to invoke a sense of familiarity with the objects and the space itself, a principle taken from the interview recommendations (Figs. 1 and 2).

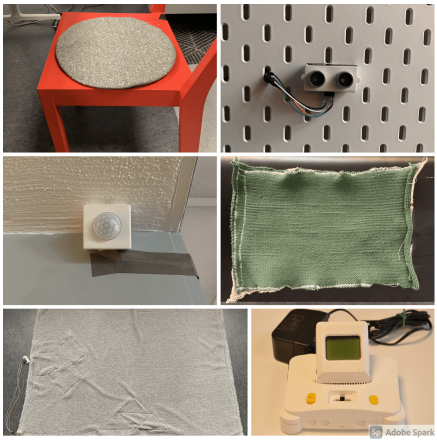

Fig. 1. Sensor artefacts

Fig. 2. Actuator artefacts

The following interfaces serve as a starting point -

- Surreptitiously placed mini speakers allowed the space to communicate through sounds. Cartoonish sounds reminiscent of small creatures, were purposely used to both lower fear and prime the inhabitants towards thinking that the space needs care. The modality of speech, offered by interfaces such as smart voice assistants, was purposely avoided to avoid triggering the fear and discomfort in inhabitants, as evidenced by the interviews. Sounds are triggered randomly, in response to events occurring in the space, the space's moods, and interactions with space's other interfaces.
- Haptic feedback, in the form of vibrations and embedded into soft surfaces such as carpets and knitted material, served to both emphasize the audio interface and act as a more persistent channel for communication. Triggered in response to actions such as stroking and pressing the surface, the intensity and frequency of vibrations vary as the strength of the 'emotions' felt by the room and feedback given.
- Visual feedback using LED lights that changed color and intensity depending on the space's mood and as feedback to interactions. Additionally, a lamp already installed in the area also serves as a channel for communication, to mitigate the inhabitants' tendency to localize the anthropomorphic entity to just the interfaces. Similar to the audio and haptic feedback, visual feedback also triggered in response to events and interactions occurring in the space and the space's moods.

– Motion and ultrasonic sensors allowed the use of physical presence as an interaction modality. They allowed for the response to and awareness of inhabitants in the space's vicinity. Additionally, a servo motor actuator with a set of 3D printed 'eyes' provide feedback through rotational movement.
– Electrically conductive threads and fabrics (along with polymers such as Velostat) when sewn or knitted into other fabrics allowed for the creation of pressure and touch sensors. These enabled interactivity to physical actions such as touching, stroking and pressing these soft surfaces.

Sensors were created using Arduino programming kits and the different systems were connected to each other via a local area network using the MQTT protocol [32], with an MQTT broker running on a Raspberry Pi. This allowed the sensors to relay information to other devices by publishing to the relevant topic, to which other devices were subscribed to (Fig. 3).

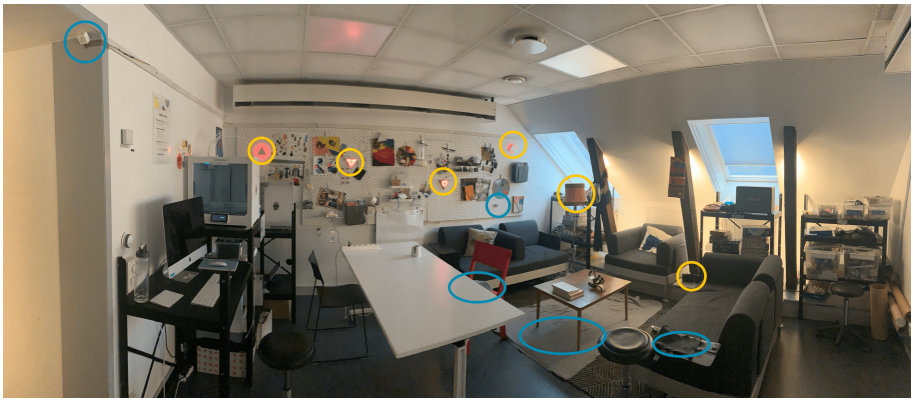

Fig. 3. Deployment of various artefacts in the studio space. Yellow indicates actuators while Blue indicates sensors (Color figure online)

From the early outset of this study, the idea of individuality was an essential trait in animistic and anthropomorphic agents. To this effect, how an animistic space would utilize the interactions mentioned above to react to various events, was to differ amongst one another. No two spaces would ever react in the same way to the same stimuli. As a result of the analysis of the interviews and related research [31], an element of randomness was introduced into these interactions. User interactions would generally trigger feedback, but not all the time. This was complemented with the narrative that the space better liked users to which it gave feedback.

A few interactions created for the space were as follows -

– Changing and saying the colour of the light actuators depending on the 'mood' of the space.
– Occasional deep breathing and sighing through sounds and fading lights.

- Rotating the 'eyes' to look at the area where motion was detected.
- Turning on the reading lamp when users sat on the sofa where the ultrasonic sensor was placed.
- Random giggling and laughter sounds
- A practical joke intended to reflect a playful and immature personality, wherein the space would randomly make rude farting noise when a user sat on the red chair and start to laugh.
- Gentle sighing when users stroked the soft surfaces such as the carpet or knitted fabric sensor.

Some of the interactions such as turning on the reading lamp also had practical uses as well (in line with interview results), since users generally sat down at that particular place to read. Due to the way they were installed, all the sensors and actuators could be also utilised in a manner similar to how they are normally used in a 'smart space' context as well, such as being used to detect presence or absence, to turn on/off lights, etc. Such interactions, as well as future artefacts would be introduced to the space with the narrative that the space has 'learnt' new skills, greatly increasing the scalability and functionality of the system.

4.3 Focus Group Results

The focus group results are presented as a chronological record of events which generate several observations and insights about how users behave in and feel about the space. These observations yielded several pointers on how to progress the study and corroborated the insights and theories used to develop the prototype space. The observations are presented in **bold**, followed by *quotes* from participants to support them. Citations of the participants are shown together with an identifier FGPn, where n is a number that represents each participant.

The discussion started with general questions similar to the initial interviews, that explored whether the participants could ever consider an entity such as a space or room to be alive. The participants initially chose to remain seated but they were quick to notice the random interactions that space made, such as the lights changing colour, random laughing, giggling and breathing sounds. After a few such events, the participants began asking why the space was behaving in such a fashion. The interviewer repeated the rhetoric that they did not know and encouraged the participants themselves to explore and figure out the reason for the space's behaviour. After this, the participants became more curious about investigating and understanding the room, which brings us to the first observation -

The prototype space instigates curiosity amongst the inhabitants to investigate and explore the space further.
This was an observation that all participants agreed upon. The interactions and feedback of the space greatly stimulated their curiosity to explore the prototype space, which is something they say they would not have done otherwise as evidenced by the following quote -

"I think we have been kind of like... touching different things, just to sort of see if it might cause the room to react." - FGP 6

As participants began to explore the room, they began to uncover some of the interactions with feedback, such as the 'head' rotating to look at the entrance due to a motion sensor detected event and some random events such as sighing or deep breathing sounds and the lights dimming in response. Whenever such events occurred and occupied the participants' attention, the interviewer would ask the participants why they thought the space was behaving in such a fashion. This leads to the second observation -

Participants create their interpretations of the space based on how they perceive the interaction.
Participants sometimes created their own stories and assumptions about the room, even though they were not told anything about the space, as seen in the following quote -

"Even now, for quite some time you've been pretty quiet. And now he just sighed massively and the lights went off. That was sort of interacting to us having a more or no serious conversation. I feel like because we were talking about how we don't want it to interrupt it kind of did that." - FGP 6

Continuing with the discussion, the participants were asked how they felt about such an interactive space and how they would feel if the space could talk or if they were able to talk to the space through voice assistants such as Alexa or Siri or if the space had entities that were moving autonomously in it, such as Roomba vacuum cleaners. This brings us to the next observation -

The prototype space feels like a novel form of interaction.
Participants reported that the space felt like a novel form of interaction different from other types of ambient computing or voice assistants. When asked about introducing moving artefacts and voice assistants such as Alexa or Siri into the space, participants felt that it would detract from the experience currently provided. They felt that such interactions were separate from the level of interactivity offered by the space, as heard from the following quote -

"This has a different kind of feel to it... It feels more subtle and in the background that gives a cozy feel... Moving objects would take away from that." - FGP 6

While the discussion was ongoing, the space would continue to perform random activities and interactions such as making noises and changing light colours. Over time, this began to have effects on the participants as seen in the following observation -

Randomness needs to be balanced.
Participants felt that the randomness of the interactions instigated their curiosity to investigate why the space did a particular action. However, at the same time, participants said that they lost interest if they could not discover a reason for feedback, or if they began to feel that the interaction was too random, as mentioned in the following quote -

"It's like a fine line. If it's super responsive like when you move there, it turns blue or you do something like that, orange. But then if it feels a bit too random, then you'll begin to be like, oh it's just random and that makes it boring." - FGP 2

This also brought the discussion to the topic of annoyances and frustrations, where the participants had some insights

Adaptability was required to prevent interactions from being annoying.
Participants felt that it was important that the space understands their current moods and feelings and adapt its feedback accordingly, to prevent them from getting frustrated with it, as exemplified in the following quote

"...it has to be reactionary. So if you're not in a good mood, then maybe it does cause quiet. It doesn't interact with you too much. Whereas when you're in a good mood or you're waking up for breakfast and you want good music and things like that." - FGP 3

A public or multi-user space has different people who engage with it, each having their own likes and dislikes. So, what is fun and interesting to one person need not be so to another and the space could perhaps behave differently to different users, allowing for different interactions for the same stimulus but different users. A similar parallel can be drawn in the pet analogy, wherein pets such as cats or dogs engage differently with different people depending how they perceive that person.

Exploring the topic of annoyances concerning the space, also brought the discussion to fears and discomfort. The following observation was noted -

Participants felt uncomfortable when an interaction was too human-like.
Interactions that were considered too human-like by the participants, such as the sighing and colour change sounds, made them feel uncomfortable as they did not expect an entity such as a space to behave like a human.

"I don't know, it's too much trying to imitate a human. And, like, at the same time, obviously not a human. Well, I would relate more to it if it was more non-human?" - FGP 1

Making something life-like also runs the risk of making it more human-like as well. This can trigger discomfort in users due to cognitive dissonance. The discomfort so triggered, can even become fear, depending on the user's prior prejudices and perspectives.

In addition to such fears, fears relating to privacy were also brought up in the discussion and yielded the following observation -

Privacy concerns were not considered of significant importance as long as the data remained localised.
Participants did not immediately bring up any privacy concerns with such an environment, but mentioned that they would prefer data collected to be localised.

"I would say like, I need my data to be localised; the data that you collected should not go beyond the house." - FGP 4

Towards the end of the discussion, the participants were asked about how they felt about having the different interfaces (sensor and actuator artefacts), they discovered, spread out in the room. This received the following feedback -

Spreading out and blending of artefacts adds character to the room. Participants felt that the artefacts blended well with the environment, which added to the space's immersive experience. The spacing and placement of the artefacts led to the participants attributing the reactions as a quality of the space itself and not localised to a particular object.

"I think what brings out that this room has this personality is maybe that these elements are placed in different places of the room... so it's not like in one spot. But here you have something to see and it looks like eyes, but there you have a voice." - FGP 5

At the end of the scripted discussion, the participants were debriefed about the purpose of the focus group. They also felt more comfortable wandering about and interacting with the space afterwards, mentioning that they thought it might be impolite to do so, during the discussion. It is also worth mentioning that the participants did not discover all possible interactions with the room. The haptic cloth interface and its vibrations were not discovered. This may have been because the created artefact was too small and inconspicuous to show its affordance. The cushion and associated laughter sound was also not discovered by the participants and was demonstrated at the end by the interviewer.

5 Discussion

By involving users in as many stages of the design process as possible, and by creating a prototype space, we gained insights on how to utilise animistic design principles in spatial interaction design. We also address the issues and criticisms levied on animism and anthropomorphism in design and discuss on how to utilise this in more broader contexts of behaviour studies, behaviour change, affective computing and so on.

What are the main takeaways from the study?
As an exploratory study, our results provide an indication of how users would tend to react to a space that is self aware and the idea of a self-aware space intrigues users as much as it frightens them. The creation of the prototype space and the observation we obtained from observing users in it, provide both a foundation and areas of interest for future studies. The positive aspects identified by users can turn out to become principles that guide the creation of future spaces while the issues pointed out or criticisms that users levied upon the space, provide critical points to ponder on. Could issues such as annoyances from certain interactions or being adaptable to different users provide critical spaces for both the user and space to learn from each other? It also points the

direction for future development of the space, such as both the space and users requiring new interactions to be able to both communicate their frustrations with each other. Coupling randomness with animistic narratives can lead to users behaving differently to interactions that did not occur when stimuli was provided to the space by the user, such as sitting on the chair and not having the space play the prank. Instead of perceiving such an interaction as a failure on the part of the space, users were curious as to why the space did not react to them. These add additional dimensions to interactions in physical systems, outside of the traditional stimulus and response cycle.

Expanding the paradigm of Affective and ubiquitous computing?
Affective computing is often pursued from anthropocentric perspectives, i.e. what can the computer or entity do, if it understands the user's emotions? In this study, we chose to design from the opposite perspective, a thing-centred perspective, i.e. what can the user(s) do if they understand the entity (in this case, the space's) needs? Motivating users to pursue such a line of thought requires additional layers to be added in the design. Animism and anthropomorphism are compelling concepts that can help in achieving this. If users begin to consider the entity as alive, they could interact differently with it and be compelled to take care of it.

Expanding and extending the paradigm of animism to a larger entity such as a space, instead of localising it to single artefacts, opens up the design space and allows for the study of user behaviour which could result in new interactions and design strategies. In addition to using these observations for the creation of animistic spaces, these insights can also be taken as broader recommendations for designers aiming to stimulate empathy and emotion for various designed artefacts.

We argue that animistic characteristics and narratives open new design opportunities. It allows for products and entities to express themselves in new ways that do not need to be explicitly clear to users. Randomness and using environmental data to create new ways of expression could entice curiosity in users to understand the cause of the new behaviour/expression. By spending time with the space, users could slowly understand the cause for said new expression and react accordingly. This also has the side effect of organically prolonging novelty effects that encourage users to try new things [34]. Using strangeness to challenge usual thinking opens a critical space for users to interpret situations for themselves.

If users are able to engage more intimately with spaces and form bonds with them, they can also be a means to gain and increase user trust. A private space such as a room or home, is a very intimate environment. Although smart home technologies are becoming more commonplace, users are still hesitant to include or try them. Animistic and anthropomorphic narratives and features for homes, could provide more compelling reasons for users to try such products, especially if they were obtained with the view of 'helping the home become better' rather than from novelty or functional perspectives, in addition to potentially improving user

confidence and trust in such systems, as shown by the study that showed increased levels of user confidence in cars with anthropomorphic characteristics [9].

Future Work and expanding into broader contexts
The aim with this line of research is to investigate through more longitudinal studies in the future on whether emotional and intimate bonds can be formed with animistic spaces and subsequently whether those bonds can be used in creating design strategies for various other domains such as behaviour change, mental health and sustainability. By reframing goals as requirements necessary to the well-being of the space, an entity which its user cares for and takes care of, users could be better motivated to achieve them. Since, home spaces are already being endowed with a great deal of sensing technologies, such as in the smart grid [38], adding a layer of animism and reframing electricity consumption as not a user goal but a requirement for the well-being of the house can potentially help users engage more with such systems, in addition to overcoming their fear and biases towards such sensing technologies. In extension to this, allowing for collaboration and competition between different spaces, and observing how users behave in such scenarios is also a line of research worth pursuing. From a well-being perspective, the Covid-19 pandemic has put the focus on staying at home for a prolonged period of time, and the health issues that might follow from this. Spending time in a room that is 'alive' and that engages you in activities that benefits your health could be explored as future work.

6 Conclusion

This two-part study investigates the application of animism and anthropomorphism in interaction design and HCI, with particular emphasis on spatial interaction. Qualitative research uncovered various insights that designers can use when applying animism and anthropomorphism to their creations, to increase their functionality and emotional value. It also yielded a new perspective that bears merit for further investigation and research. One that designers can employ for inspiration and visualization when designing for complex interconnected systems. Finally, a prototype space with animistic and anthropomorphic qualities was created and evaluated with inhabitants. By opening up the design space, the prototype serves as a foundation and sandbox for future research not just into spatial interaction design, animism and anthropomorphism but also into other domains and concepts to which it can be linked, behavior change and mental health.

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