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**Artists in Residence Case Studies**

**Context: A collection of use case scenarios for TAS researchers.**

**Title of Work:** Museum of the Mirrored Self

**Abstract:**
*The Museum of the Mirrored Self* features a series of prototype interactive mirrors designs, each prototype represents a journey from the ancient, mythical, superstitious and instinctive uses of reflective surfaces to present day research into interactive mirror technologies for health and wellbeing, protest and performance, policing and security. This work extends previous work by the artist Rachel Jacobs that explored performative uses of interactive mirror technology - involving the design of a series of 'performative mirror spaces', as part of *'Invisible'*, an international collaboration across the UK and Brazil in 2017.

**Description –**
*The Museum of the Mirrored Self* involves a display of four playful prototype interactive mirrors. Created during the artist residency and presented at the TAS All Hands exhibition, and during a workshop with PhD students from Horizon CDT, at the Mixed Reality Lab, University of Nottingham. These provocations are designed to be experienced as a museum display, that follows the historical trajectory of mirror technology, from ancient uses to experiments with contemporary interactive technologies.

Alongside the display, an article was published online exploring how the history of mirrors might help us understand the challenges and opportunities for developing new designs of interactive mirrors for health and wellbeing, performance and protest.

Mirrors, as we think of them now, are relatively new technologies. Yet reflective surfaces have held an important role in human cultural and collective consciousness, referred to in myths, stories and drawings from the first humans as a key component in ritual, death rites and sacred activities. Used by healers as a way of treating and diagnosing people, as well as providing a developmental tool for our ability to distinguish and recognise our public selves in relation to the 'other'.

***Where is the risk/vulnerability?***
*The Museum of the Mirrored Self* explores the disruption of trust in our mirrored reflections, in order to explore the challenges and opportunities of using interactive mirrors for diagnosis, to encourage well being, and explore the uses of interactive technologies across the domains of security, performance and protest. Developed alongside the TAS for Health research, this series of meditative and playful prototypes were designed to be embedded in several different contexts: as diagnostic interactive mirrors installed inside the home, as an immersive installation, or as portable devices and wearables that people can take out and about. As provocations, they act as an aid for participants to consider questions of ethics, privacy, security and trust in the design and use of interactive mirrors.

The evolution of mirror technology has been based on a search for an 'accurate reflection'. The move from the ancient mythical, sacred, ritual, spiritual and medicinal uses of mirrored reflections came as the materials used for reflection became clearer and more accurate. The most recent developments in mirror technology, in contrast, moves away from the desire to create the most accurate reflection. An interactive mirror begins again to disrupt, hide and/or reveal 'things that are not physically present'.

***This work is designed to raise a series of questions:***
If mirrors are often seen as a metaphor for truthfulness, how does this impact the design of interactive mirrors as 'trustworthy autonomous systems'? How does our relationship with a mirror change when we become aware of it not only reflecting back ourselves and the world but acting as a capture device, and potentially an autonomous diagnostic tool with another hidden 'viewer' intervening with the reflection?

When the reflection is accurate, the surface is flat, it appears to us that there are no longer room for other possibilities and we begin to believe that the reflection is accurate and 'the mirror never lies'.

The technologies embedded in mirrors, to enable interaction have been shown to be controversial. In particular, research shows that face and body tracking and facial recognition software have built in biases with difficulties detecting our different types of bodies, mobility and movement, skin colour, hair and body shape [1]. This raises ethical questions for both designers and users, particularly when these technologies are used as a tool for security, policing and health, in particular for people marginalised in society for their race, gender, physical and mental health.

***Where is the user choice?***
When the mirror starts to capture data with 'expert intervention' as proposed by the 'TAS for Health' research project, requires elements of touch for touch screen interactions, using face recognition that may hold biases and judgements (as a diagnosis tool or for behavior nudging) does this turn the freedom, intimacy and privacy of the mirror space into a new space of control?

The *'Museum of the Mirrored Self'* played directly with issues of user choice, control and the hidden presence of an 'other' within the mirror space. In *'The Diagnostic Mirror'* prototype an interactive experience plays out 'within' the reflection in the mirror. A voice claims to be helping the user to relax and reduce their (fake) heart rate, when the participants fake heart rate rises not only is their choice and sense of control deliberately taken away from them, the reflection of their face also disappears and is replaced by a threatening and distorted face.

*The Diagnostic Mirror* plays with the historical context of the mirrored self, alongside issues of trust and truth. Our relationships to mirrors in the past have been shown to be gendered and influenced by the contexts and cultures of where we encounter our mirrored selves. In the past, wealthy European women were seen to substitute mirrors for the 'male gaze', providing an element of agency and a sense of a secret self over the expectations of how they should look and behave in public. Whilst wealthy European men's relationships with their mirrored self tended towards seeing mirrors as a way to reflect status, whilst often using the mirror as a tool to extend vision (for instance, attached to a gun), and for diagnosing injury, ill health and closeness to death - particularly when hand mirrors were taken onto a battlefield.[2]

Mirrors can also be seen as a tool of liberation. People from all backgrounds were able to interact with mirrors as ‘items that could be used without having to be touched and used more widely than just by their owners’. This was particularly relevant to African Americans in slavery providing an opportunity to come to know their mirror selves through seeing their reflections in a mirror without intervention. This unique ability for a mirror to reflect without judgement whatever is in front of it, becomes a tool of empowerment and revelation. [2] When a mirror requires touch or has in built interactions this ability to view our reflections as a private moment without intervention is potentially disrupted, removing our ability to know our mirrored selves without the judgement of others.

***What are the standout characteristics of this work, its merits in context of TAS research and limitations?***

In response to collaborating with researchers on the TAS for Health project, I became very interested in exploring whether interactive mirrors could be used as a trustworthy diagnostic tool that might one day be part of people's everyday lives – installed in their homes or carried as a portable or wearable device.

The technical issues I encountered focused on the now well known concerns around the built in biases in the facial recognition software often used in interactive mirror experiences, the inability for tracking software, such as the Kinect, to detect different body shapes and sizes, mobility and movement, skin colour and hair. The prototypes also aimed to explore issues of privacy, gamification and how non-experts interpret scientific data, particularly biological and climate data. This linked into four of my previous works – a mobile phone game controlled by heart rate data Heartlands ('Ere Be Dragons) [3], A Conversation Between Trees [4], The Prediction Machine [5] and Future Machine [6].

***What aspects of Trust explained/explored/exploited? - e.g., built, broken, instantaneous, repaired, appropriate, trustworthiness***

These concerns led me back to the history of mirrors, to explore a series of questions published in a blog post here: https://www.i-am-ai.net/mirroredself/

This article explores the following questions of trust across all the prototype mirror designs:

1. What is unique, attractive and novel about the mirror object on its own terms?

2. How have different people and cultures around the world traditionally interacted with mirrorrs?

3. How does the analogue technology of a mirror make this different from other technologies (e.g a phone, a camera, a screen)?

4. What happens when we layer data capture and interactivity onto these existing ‘analogue’ technologies?

5. How does using a mirror reflection make the interactions different from an interactive screen or projection – and therefore the trustworthiness of these interactions?

The key prototype in the Museum of the Mirrored Self display - *The Diagnostic Mirror* - was developed in response to the questions above. Participants were invited to sit in front of a tryptic of mirrors. The central mirror was semi-transparent and interactive, behind the mirror a monitor connected to an app on a tablet via a Roku adaptor played out an interactive display created by myself and my colleague Robin Shackford, tablet' was also hidden behind the mirror and the webcam worked through the mirror for facial recognition and tracking the head movements of the participant. The monitor was placed some distance behind the mirror. This made use of the space between the mirror and the monitor, that created a depth within the reflection – as a 3D effect - outlined in our previous research [7].

The users were invited to sit down on a stool in front of the mirror and adjust the height of the stool and distance from the mirror, so their head was in the right place to view both the reflection and the interactive visual elements. A disembodied voice began a meditation exercise involving deep breathing to control the user's heart rate. A fake heart rate number then appeared at the top of the screen. The aim of the exercise stated by the voice was to keep the user's heart rate low by meditating on their breath. As the heart rate number lowers, and in response to the stillness of the participant's head movements, organic, flowing visual imagery is generated around the reflection of their head, this also moved with their head (the graphics appearing within the reflection in the mirror). The lower the number the more organic the imagery becomes. As the heart rate becomes higher the voice changes and becomes more controlling, the visual imagery becomes spooky and loses it's 'living

organic form' to become more like ghostly dead trees, the voice threatens to take control. A grimacing male face eventually appears over or within the reflection of the participant's face (depending on how close to the mirror the participant is sitting) and the voice states it has now 'taken control'. There is then a game between the participant and 'controller' to take control of the reflection - by the user slowing their heart rate. This eventually happens and the participant's reflection returns. Clearly, as the heart rate is fake and is in reality controlled by the app the participant has no real control over the 'game' and what happens within the experience.

When this was tested at the TAS All Hands exhibition, many participants believed that the heart rate was real and couldn't understand why their heart rate was so high and they couldn't regain control of their reflection. This led to very interesting feedback and conversations over trust, suspension of disbelief, control and safety. The presence of a new 'other' face in the mirror appeared to add to a feeling of uncanniness and loss of control, in contrast to the soothing voice that attempted to help the participant slow their breathing.

The other prototypes involved different types of mirrors, each acting as a conversation point and provocation towards future works, echoing the themes published in the blog article:

1. Divination Mirror – a hand mirror had the same user experience as the diagnostic mirror but played out within a less 'accurate mirror surface'. Yet the user had more control over the view, distance and light reflections. The hardware of the mirror had the potential for further elements of uncanniness built in. Designed to explore if this changed the expectations and suspension of disbelief in the interactions.
2. Labyrinth of the Mirrored Self – a 3D video walkthrough and 3D model of an immersive mirror installation. The labyrinth concept was based on a traditional fun fair 'hall of mirrors'. The experience begins with the user being surrounded by full body sized flat mirrored surfaces, reflecting multiple reflections. These reflections become semi-transparent, introducing elements of interactivity – such as the spooky face from 'The Diagnostic Mirror' being reflected back. As the participant walks deeper into the labyrinth their reflections become further disrupted, multiple, different shaped mirrors breaking up the reflection enabling the user to loose a sense of scale, trustworthiness and reality. Finally the user returns to being surrounded by an accurately reflective surface, reflected within a peaceful meditative scene, yet behind these 'peaceful' mirrors lies a hidden room, shadows reveal other people hidden behind the mirror watching you. This prototype of an immersive experience was created in collaboration with 2 masters architecture students.
3. The Mirrored Warrior - A wearable interactive mirror costume was designed to be worn by environmental protectors and performers, as a way to move through the world whilst reflecting the environment around them. The design was based on a Samurai warrior costume. An interactive mirror at the front provides a way for the wearer to capture, visualise and interpret their own environmental and bio data, exploring how the wearer might take control over their interactions with the world and gain autonomy in situations of environmental protest.

***Domain and setting – where does this work sit?***

Although this work was designed in response to the TAS for Health research and using interactive mirror technologies, the questions raised and the playful and historical context of the work are applicable across many domains. Whilst interactive mirror technology has it's own specific context it is arguably not that technically different from other apps that uses camera images, facial recognition and bio data to quantify, diagnose and play with our sense of self, health and well being. This research therefore has the potential to support research across other similar technologies (as described in this blog written by the artist: https://www.i-am-ai.net/reflections-in-the-mirror-space/).

***Is there an application area or perspective that you explored?***
This work focused on the TAS application area of health, remote diagnosis and well being, although additional interests and cross overs with the more general application of interactive mirrors in areas of security, performance and protest were also explored in this work.

***Description of technology, test environment:***
These prototypes were produced for exhibition at the TAS All Hands meeting and testing in lab or workshop environments. The technology and design reached during the residency was not robust enough or developed to be applied 'in the wild'.

The original concept was to develop an interactive meditative device that could be installed in a local library, or lent out by libraries as a playful health and wellbeing aid. Whilst this was not possible in the time of the residency, the prototypes provided an opportunity to play with how this concept might work, and some of the challenges of developing these devices for public deployment. The prototypes raised concerns around the efficacy, trustworthiness and biases of the technology, alongside how reliable this might be as a meditative 'psycho-technology'. Despite these concerns, the Museum of the Mirrored Self has the potential to be developed as an artwork or each prototype as separate artworks in their own right, given the right opportunity and context.

***Future opportunities for researchers to use and apply the work:***
'The Diagnostic Mirror' is available to be used in workshops and research contexts as a provocation to think about AI in terms of trust, privacy and control, particularly for researchers interested in developing applications for remote diagnosis, health and wellbeing.

The blog and article are in the public domain to support future research and future designs of interactive mirror technology and has the potential to be developed into an academic paper.

***Are there any gaps that you have seen in the range of use cases and domains covered by the TAS (Trustworthy Autonomous Systems) project?***
I think a key area missing for TAS is research into AI, sustainability and human-and beyond human/nature interactions. Exploring questions of how AI might support the protection, conservation and public engagement with issues of climate and environmental change, and the non-human natural world. A focus on research into the challenges, opportunities and issues that are raised by the impact of AI technologies on the climate and environment, versus the role technology can play in mitigating climate and environmental change are greatly needed so that HCI researchers and interaction designers can explore what we need for the future and not just what is possible - as discussed in the Responsibility Re-Imagined workshop.

References

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Resources – In the 'museumofthemirroredself' folder

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