https://doi.org/10.2352/EI.2024.36.2.SDA-355

VR Visualization of Interspecies Relationships for Co-Design Practices supporting Empathy Building and Perspective Shifts

Tori Simpson[1,2,], Harry Hosker[1,2], Tokushu Inamura[3], Yasuyuki Hirai[3], Bjorn Sommer[1]*
[1] School of Design, Royal College of Art, Howie Street, SW11 4AY London, United Kingdom
[2] Dyson School of Design Engineering, Imperial College London, Exhibition Road, London SW7 2AZ, United Kingdom
[3] Department of Strategic Design, Faculty of Design, Kyushu University, 4-9-1 Shiobaru, Minami Ward, Fukuoka City, Japan
[*] Corresponding author: torisimpson@network.rca.ac.uk

Abstract

In August 2023, a series of co-design workshops were run in a collaboration between Kyushu University (Fukuoka, Japan), the Royal College of Art (London, UK), and Imperial College London (London, UK). In this series of workshops, participants were asked to create a number of drawings visualising avian-human interaction scenarios.

Each set of drawings demonstrated a specific interaction each participant had with an avian species in three different contexts:

- *the interaction from the participant's perspective,*
- *the interaction from the bird's perspective, and*
- *how the participant hopes interaction will be embodied in 50 years' time.*

The main purpose of this exercise was to co-imagine a utopian future with more positive interspecies relations between humans and birds. Based on these drawings, we have created a number of visualisations presenting those perspectives in Virtual Reality. This development allows viewers to visualise participants' perspective shifts through the subject matter depicted in their workshop drawings, allowing for the observation of the relationship between humans and non-humans (here: avian species).

This research tests the hypothesis that participants perceive Virtual Reality as furthering their feelings of immersion relating to the workshop topic of human-avian relationships. This demonstrates the potential of XR technologies as a medium for building empathy towards non-human species, providing foundational justification for this body of work to progress into employing XR as a medium for perspective shifts.

Introduction

Design is often easily recognized as a significant force in shaping human societies, influencing everything from functionality to aesthetics of specific objects to broader systems and infrastructures that we interact with on a consistent basis. The most recent dominant force and framework in the design discipline has been human-centred [1], [2], prioritising human needs, experiences, and usability in the creation of products, services, and environments, with minimal recognition or awareness of the wider reaching implications and effects of designed outputs on the surrounding environments.

In a human-centred design process, relating to participants and understanding how they relate to their surroundings, is an essential input throughout. Empathising with users is the principal way in which designers generate insights and understanding regarding a given problem space during the research phase [3], [4]. The empathy built is therefore rarely considered itself as a design output. There is a unique opportunity to enable a perspective shift for designers in the age where human-centred approaches are waning. With a "more-than-human" shift in designing to include the environment, planet, multi-species, and other embodiments [5] - this paper argues that empathy building for these other species is an imperative parallel for understanding and appropriately designing for any situation where other species are affected or involved.

As society grapples with the urgent need to address environmental and biodiversity crises, the role of design is evolving [6]. No longer can design be solely about human convenience and aesthetics; it must also be a tool for environmental stewardship, protection, and restoration. By shifting the perspective from human-centred to more-than-human-centred, designers have the potential to lead the way in creating a more sustainable, equitable, and thriving world for all inhabitants. However, there is still a substantial lack of existing design methodologies and approaches to guide designers in creating more-than-human-centred design interventions, and that is a secondary goal of the work described in this paper.

The work presented is a continuation of co-design workshops, constructing alternative futures, that were run in a collaboration between Kyushu University (Fukuoka, Japan), Imperial College, and Royal College of Art (London, UK). The motives, content, and outputs of these workshops are explained in greater detail in the following section. After completing the workshops, the aim of the group expanded to developing the design methodologies further, by creating a better sense of immersion for workshop participants, this expansion of thinking is what prompted the use of XR technologies.

In previous work, we established *VR (Virtual Reality)*-based methods to visualise different 3D scenarios from a bird's perspective. For example, a *stereoscopic 3D (S3D)* monitor setup with an array of 3x2 devices was used to visualise flight paths of birds based on pre-recorded GPS coordinates. This setup was used by expert users and scientists to explore different patterns - such as the leader-follower model, or the spiral-based patterns created by a flock of storks approaching sky - from the bird's perspective [7]. Based on this work, we developed an exhibition setup which showcased three different 360-degree scenarios of a flock of storks along the journey from Lake of Constance to Africa (based on GPS coordinates) which was on view at an exhibition for several weeks, motivating hundreds of visitors to explore the perspective of a particular stork [8]. Other work explored in depth how animals can be embedded into and experience virtual environments [9].

The work discussed in this paper expands on the workshops conducted in Japan and establishes a first prototype virtual environment facilitating a perspective shift. For this purpose, we decided to use a fully-immersive approach using Virtual Reality

technology. We decided not to use a see-through approach (i.e., Augmented Reality), in favour of fully immersing the user in the virtual environment, providing the visual perspective of the bird, as shown in the drawings created during the initial workshops.

Foundational Work: Workshops in Fukuoka

This project began as an ethnographic design research study, aiming to examine how practitioners work with and design for avian species; with the eventual goal of building a suite of practical methods to help designers shift their perspectives towards understanding and including avian species as equal stakeholders in design and decision-making processes. The VR visualisations presented in the iteration of work this paper discusses are based on a set of drawings done by a participant in one of the workshops run in Japan as part of the wider project.

In August 2023, two co-design workshops were run in the prefecture of Fukuoka, Japan. Both were in collaboration with Kyushu University, each with a different industry partner. The first workshop was run in collaboration with Fukuoka Zoo, and the second with Omuta City Zoo and Tomodachiya Picture Book Museum. These workshops were run as part of the mentioned wider body of work that aimed to create tools and methodologies for designers to shift their perspectives to understand the lived experience of other species, with the eventual goal of including more-than-human species as equal stakeholders in design outputs.

Collaborating with zoos provided the opportunity to work with practitioners who regularly design and make decisions for other species. Whilst it is recognised that Animal Welfare Science and Zoological Sciences have made much progress in considering animals in their decision-making, the developing practices are still vastly detached from the field of design.

Designerly, arts-based approaches have a lot of potential in helping practitioners to include other species as stakeholders within their interventions, but dialogue between the aforementioned spaces is still nascent and must continue to be developed. The aim of the specific co-design workshop in question was to help participants shift their perspective towards understanding a bird's point of view, followed by imagining possible futures of relationships and interactions between birds and humans. Arts-based research methods were employed, with participants being asked to draw their responses to various prompts, rather than discuss. Arts-based methods can be broadly understood as "tools adapt the tenets of the creative arts in order to address research questions in holistic and engaged ways in which theory and practice are intertwined" [10]. In this case, arts-based approaches were chosen to help participants engage with the abstract research questions in greater depth, as well as mitigate the language barriers between participants and researchers, given the work was conducted by English-speaking designers working in Japan.

Both workshops followed the same structure, and between the two workshops, that each ran for 90 minutes, there were a total 21 participants. Following some warm-up drawing exercises, designed to help participants feel more comfortable in mark making, the main body of the workshop consisted of three longer drawings. For this series of drawings, participants were asked to think of their most memorable interaction with a bird, and draw this interaction from different perspectives in each drawing, following these prompts:

(1) The participants' own perspective,
(2) the bird's perspective, and
(3) an optimistic perspective on how the interaction might look in 50 years' time.

The intention of asking participants to imagine a specific interaction was to eliminate the potentiality for abstraction and confusion of providing more broad prompts such as: Draw human avian relationships as they currently are. Participants were also given a range of drawing materials, so they were able to choose which they felt most comfortable in using. Finally, participants were asked to annotate their drawings with short notes, to contextualise the participants drawings and limit the need for making assumptions about what the participants were trying to convey when conducting visual analysis.

A key learning from the initial work conducted was that participants – even when tasked with presenting the bird's perspective – often presented a human-centred viewpoint. An example of when this could be seen was in a drawing of birds looking back at humans whilst flying away. This observation led the authors to consider how they could continue this work to further immerse participants during the workshop setting, with the goal of creating a more robust and lasting understanding of avian perspectives.

Methods

With emerging AI technologies, it is feasible that in the near future, software will be able to translate drawings into 3D assets to create VR environments [11]. The intention of the presented iteration of this project is to test whether a further step within the workshop, translating participant drawings to VR, would create a more immersive experience for participants, allowing them to further develop their shift in perspective.

With this iteration, the design aim has been updated to include further immersing participants during the workshop setting, with the goal of creating a more robust understanding of avian perspectives.

Virtual Reality-based approaches are increased popularity in many design and science based areas, such as Immersive Analytics [12], [13], Immersive Design Engineering [14]. This methodology in context of avian species draws its inspiration, and theoretical foundation from the aforementioned previous work in which the authors, whilst exhibiting their work, found that VR created a heightened sense of immersion and a more robust understanding of other species perspectives for participants [7], [8], [15].

Based on these observations, the following methodology using VR technologies was implemented:

Technology & Setup

Figure 1 illustrates the integrated workflow. The drawn scene was replicated in UNREAL Engine 5.2.1, using Blender 3.5 to create importable assets and animations. Following this, the project is viewed using Meta/Oculus Quest 2 VR goggles, with keystrokes (1-3) programmed to transition between the three scenes illustrated in the participants initial set of drawings.

When demonstrating this work for data collection and feedback, printed copies of the drawn scenes are shown before the participants view the VR scene, and a questionnaire is given following the viewing to assess whether introducing the VR visualisation created a more immersive experience. The questionnaire is adapted from the Immersive Experience Questionnaire (IEQ) [16], please see Figure 6 for the adaptations. It has been streamlined to gain insights on the intervention's effectiveness in shifting users' perspective towards better understanding birds' perspective, as well as immersion. In this way, the questionnaire was drastically shortened and tailored towards a demo presentation-compatible format where participants are only willing to invest a very short amount of time to answer questions.

For the presentation set up, shown in Figure 2, we were using an Intel NUC equipped with an NVIDIA RTX 3060 and a Meta Quest 2 connected via an Oculus Quest Link USB-C cable. Users were able to freely move their head in the scene and move around in the local area, but it was not intended that they were travelling between different locations. In this way, in each scene, they were bound to the corresponding location.

The Scenarios

The design of the VR was developed using an iterative process. The series of drawings selected were chosen based on having a single consistent environment, streamlining the modelling process for the VR demonstration. Figure 3 shows the drawings selected. A first more illustrative and simplified version – including a strongly simplified bird model as well as initial sketches of the human models – was created and edited based on qualitative internal feedback to create version two.

Version two focuses mainly on creating more detail within the environment, increasing the grade of reality, and modelling a more realistic bird using animated postures. Figure 4 shows version one of the VR visualisations, and Figure 5 shows the iterated second version of the VR visualisations.

Version one was used in the early stages of development to get basic feedback about the built virtual environment. Comments from this feedback session included points regarding the movement of the water, proportions of the objects and overall realism of the scene. These early comments added to the feedback given within the team and helped to give guidance on particular areas for improvement in the early scene.

Hypothesis & Survey

The research question we wanted to explore with this approach was: 'Does translating the workshop drawings of avian perspectives and imagined futures into VR provide a better immersion experience, and a greater shift in perspective for the participant?'

To test this hypothesis, we showed individuals the drawings created within the workshop, followed by a demonstration of the VR scenes, to allow them to compare the formats, and give informed answers to questions asking which of these mediums created a better immersive experience, and better helped them to shift their perspective towards understanding a bird's point of view.

The VR Version two was demonstrated at the Electronic Imaging 2024 conference as well as in a workshop run at the Royal College of Art. The purpose of running multiple workshops was to collect information that allowed for comparison between opinions of electronic imaging experts and professional designers.

A total of 22 Participants were surveyed following the demonstrations,

- 11 professional designers from multidisciplinary backgrounds, and
- 11 experts in electronic imaging (including XR).

The questionnaire was presented to participants using a smart phone, to

1. enable them to quickly reply to the questions, and
2. indicate the short length of the questionnaire to maximise the number of answers.

Figure 6 shows the questions used during the survey as well as the different ranges; most answers where based on a 7-point Likert scale, whereas 1 was negative (e.g., "Not at all") and 7 positive (e.g., "A lot") [17].

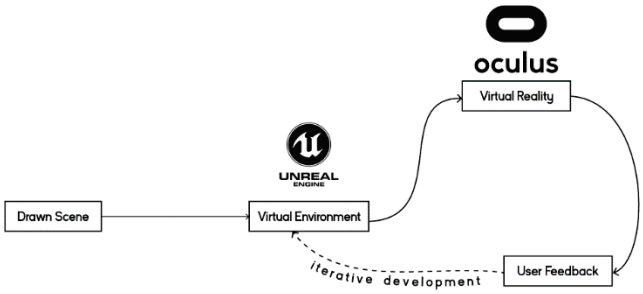

Figure 1. An overview of the technology workflow used.

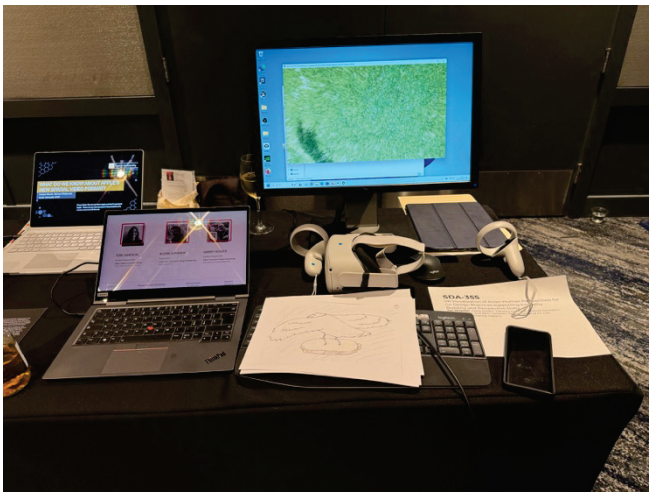

Figure 2. The technology setup used during the demonstration session on January 23, 2024.

Results

The results presented were collected over two different time periods but under the same conditions. There were two groups of participants who engaged in the demo. Namely, academics specialising in VR technologies who attended the Electronic Imaging 2024 conference demo session in February 2024 (in Burlingame/San Francisco, USA), as well as design students at the Royal College of Art (in Battersea/London, UK).

The charts presented demonstrate key findings from the results. Primarily, Figure 7 demonstrates that the difference in average voting remained consistent between academics and designers. This is encouraging as the harmonious average responses show the ability for this workshop to be used across disciplines, expanding possible future applications. The expectation is that this will enable iterations and improvements to be made uniformly without having to consider trade-offs with target audiences. The largest disagreement came in answering the question as to whether the involvement of the participant enabled them to feel as though the scenario was depicting a real experience. The proposed reason for this disagreement may be due to the nature of the question being more prominent in VR type questionnaires surrounding immersion. Furthermore, considering their involvement in the world, academics more easily equating the experience with reality is highly feasible.

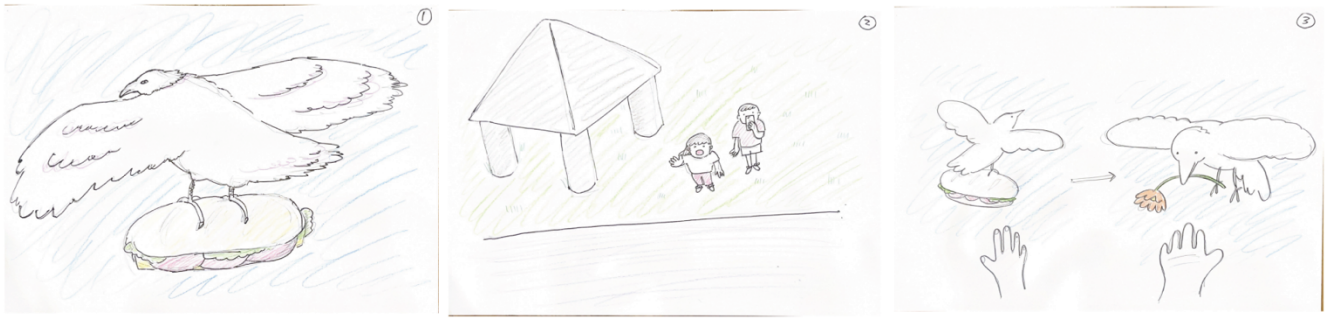

Figure 3. Three drawings produced in the original workshop in Fukuoka (Japan), each one representing one of the three scenarios as provided by a single participant based on own experiences: 1. "The participants' own perspective": a bird steals a sandwich, 2. "the bird's perspective": two people observing the bird escaping with the sandwich, 3. "an optimistic perspective on how the interaction might look in 50 years' time": the bird provides in exchange for the stolen sandwich a flower.

Figure 4. Version 1 of the drawings converted into a VR scene: an initial version as base for discussions to create version 2.

Figure 5. Version 2 of the drawings converted into a VR scene: this scene was used during the demo sessions and was the base for the discussed survey.

Observing all of the data in a box and whiskers plot (Figure 8) allows responses to be viewed with regards to variance, with three questions being particularly noteworthy. These questions all reflect how immersed and involved the participant felt in the virtual experience. This reflects on the subjectivity of the questions. Observing more closely, immersion received positive responses. Although the average score was still 7/10, indicating that immersion can be improved, the score still demonstrates a decent performance for this iteration of the workshop. The question with the largest variance also had the worst feedback. The question asked if participants ever became unaware that they were in another person's drawing. Verbal feedback during the sessions indicates that part of this is a result of the wording of the question being unclear. Multiple participants asked for clarification and therefore could have responded with variability due to lack of clear understanding.

To what extent did the scenario help you to imagine a bird's perspective?
Not at all 1 2 3 4 5 6 7 A lot

To what extent did you feel consciously aware of seeing another species' viewpoint?
Not at all 1 2 3 4 5 6 7 Very much so

At any point did you find yourself becoming so involved that you were unaware you were in someone else's drawing of an interaction?
Not at all 1 2 3 4 5 6 7 Very much so

To what extent did you feel motivated to immerse yourself?
Not at all 1 2 3 4 5 6 7 A lot

At any point did you find yourself becoming so involved that you felt the real experience?
Not at all 1 2 3 4 5 6 7 Very much so

How immersed did you feel? (10 = very immersed; 1 = not at all immersed)
1 2 3 4 5 6 7 8 9 10

Figure 6. The questions from the questionnaire.

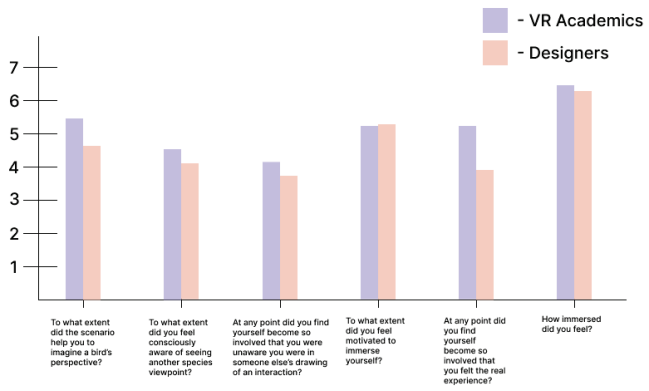

Figure 7. Bar chart representing average score to each question across the two participant groups.

The final question in the given survey elaborated which delivery method was preferred; responses have shown that a strong majority preferred the 3D immersive representation (see Figure 9). This validates that progression from the previous drawing workshop and demonstrates that further iterations should be spent in this space for greater engagement and perspective shift.

The final feedback given by participants were general comments. This revealed several particular places where the scenarios and assets could be improved for greater immersion and comfort of the participant. In particular, the second scenario which involved a moving camera to emulate the birds flying. This resulted in a bobbing motion that received consistent negative feedback due to the dizziness it incurred when participants freely moved their own head around. The overall environment received positive feedback however the assets being unrealistic in size, texture, and placement negatively impacted participants' sense of immersion. Finally, observations during the demonstration revealed that in the final scene, a lot of participants reached out to grab the flower which was being presented to them by the bird. This was backed up with feedback saying that interaction would have enhanced engagement in the experience.

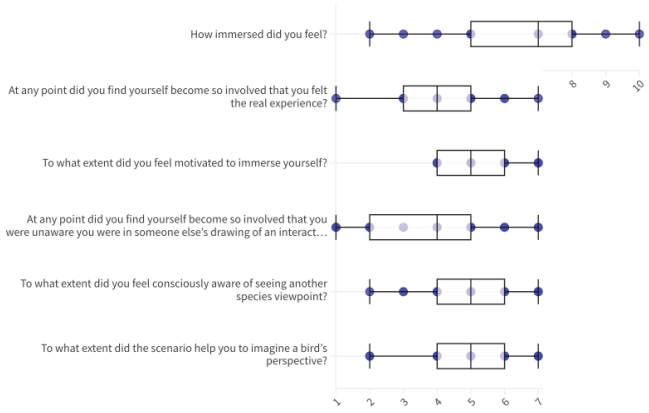

Figure 8. Box and whisker plots of individual responses to each question in the immersion survey.

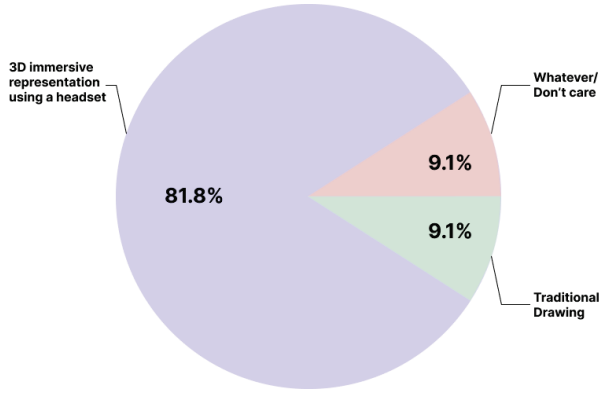

Figure 9. Pie chart representing the distribution of responses to question of preferred workshop method.

Discussion

The current work is an iteration on a series of drawing workshops conducted in summer 2023, which looked at examining human-avian relationships. The development of these perspectives into VR was to enhance immersion of participants into the scenarios and exacerbate the effect of perspective shift.

The decision to incorporate virtual reality technologies was a resounding success with the majority of participants indicating their preference in the medium over the original drawings. Acting on this, continued work on this project will incorporate further mixed reality

technologies and the trend of participant preference will continue to be observed and adhered to.

In the making of these scenes, the authors tried to prioritise smaller details such as the bobbing of the bird's head in the second scenario. Primarily, it was pointed out in the comments that the bird's head would be balanced in flight and not bob as indicated. It was also noted on multiple occasions that the added movement layered on the free movement of the participants, easily induced motion sickness. Therefore, moving forward, greater considerations have to be given to the physical constraints set on the participants' movement.

On the note of motion sickness, the development of the scene didn't take into full account the effects of the relatively large size and polygon count of the presented world. As a result, the produced scenes had minor lag and were shown with a relatively low FPS which diminished the experience of the participants. Giving deeper investigation to the questions being asked in future demonstrations, the scenes will undergo a decent optimisation to ensure a smoother and less jarring experience. It is theorised by the team that this factor was detrimental to the immersion felt by participants and is therefore critical to be aware of if immersion is a primary measure moving forward.

In the future, the aim is to expand the reach of the current work and implement changes to test a greater perspective shift and empathy building towards other species. This work revolves around human-avian relationships and interactions, however future work hopes to expand out to other species.

This approach is based on the prediction that in the very near future it will be possible to use AI methods to easily generate VR scenes – like the three scenarios presented in this work – based on very simple drawings or prompts. Similar methods going into this direction have been already introduced by, e.g., Wanwan Li [11].

We estimate that in future scenarios like the workshops discussed in the first part of this paper, participants can – as an alternative to drawing simple 2D sketches – create scenarios which can be shown within no time using VR headsets. Instead of demonstrating the scenarios then on a sheet of paper, the scenarios can be explored in full immersion.

The avian perspective shown in the current work is reflective of what was drawn in the original workshops. This however is of course not how the bird would have perceived the particular interaction given the difference in optical perception alone. This is the biggest shift that future work hopes to address. "In the Eyes of the Animal" demonstrates the profound effect that illustrating alternate perspectives can have on awareness and empathy [18], [19].

Addressing this, future iterations of the project are to involve other XR technologies and forms of haptic feedback to emulate other animal perspectives to a high degree of fidelity. This entails that the future intention is not to show exactly how an animal perceives the world, but rather to mimic it in order to induce a greater perspective shift.

Further iterations will also place this immersion around a particular design prompt to test the ability of the perspective shift to alter and enhance designer decisions and processes when designing for or around animals.

Based on the received feedback, it might be also interesting to explore the relevance of the grade of realism in these scenarios - e.g. by taking the uncanny valley into account [20], and/or by comparing our original, more abstract scene version 1, with the more complex and realistic scene of version 2.

Acknowledgements

This project would not have been possible without the contributions of our collaborators at Kyushu University, Fukuoka Zoo, Omuta City Zoo and Tomodachiya Picture Book Museum. Particular thanks go to Melanie Sarantou, and co-authors Tokushu Inamura, and Yasuyuki Hirai for their support in facilitating fieldwork in Japan. Thanks also go to Akiho Higano, Takahiro Yamada, and Keito Iwashita for their contributions to the foundational work done in Japan.

Abbreviations

- 2D two-dimensional
- 3D three-dimensional
- HMD Head-Mounted Display
- S3D Stereoscopic 3-dimensional (visualization)
- VR Virtual Reality

References

[1] D. Norman, *The design of everyday things: Revised and expanded edition*. Basic books, 2013.

[2] IDEO.org, *The Field Guide to Human-Centered Design*, 1st ed. 2015.

[3] T. Brown, *Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation*. HarperBusiness, 2009.

[4] U. Dandavate, E. B.-N. Sanders, and S. Stuart, "Emotions matter: User empathy in the product development process," in *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, SAGE Publications Sage CA: Los Angeles, CA, 1996, pp. 415–418.

[5] A. Escobar, *Designs for the pluriverse: Radical interdependence, autonomy, and the making of worlds*. Duke University Press, 2018.

[6] E. Manzini, *Design, when everybody designs: An introduction to design for social innovation*. MIT press, 2015.

[7] K. Klein, M. Aichem, Y. Zhang, S. Erk, B. Sommer, and F. Schreiber, "TEAMwISE: synchronised immersive environments for exploration and analysis of animal behaviour," *J. Vis.*, vol. 24, pp. 845–859, 2021.

[8] B. Sommer *et al.*, "BinocularsVR: A VR experience for the exhibition 'From Lake Constance to Africa, a long distance travel with ICARUS,'" in *SD&A Conference ERVR2019*, 2019.

[9] H. Naik, R. Bastien, N. Navab, and I. D. Couzin, "Animals in virtual environments," *IEEE Trans. Vis. Comput. Graph.*, vol. 26, no. 5, pp. 2073–2083, 2020.

[10] P. Leavy, *Method meets art: Arts-based research practice*. Guilford publications, 2020.

[11] W. Li, "Synthesizing 3D VR Sketch Using Generative Adversarial Neural Network," in *Proceedings of the 2023 7th International Conference on Big Data and Internet of Things*, 2023, pp. 122–128.

[12] B. Sommer *et al.*, "3D-stereoscopic immersive analytics projects at Monash University and University of Konstanz," *Electron. Imaging*, vol. 2017, no. 5, pp. 179–187, 2017, doi: 10.2352/ISSN.2470-1173.2017.5.SDA-109.

[13] T. Chandler *et al.*, "Immersive Analytics," in *Big Data Visual Analytics (BDVA), 2015*, IEEE, 2015, pp. 1–8.

[14] B. Sommer, C. H. Lee, N. Martin, and V. S. Torrisi, “Immersive Design Engineering,” *Electron. Imaging 2020 Proc. Stereosc. Disp. Appl. XXXI*, vol. 2020, no. 2, pp. 265-1-265–16, Jan. 2020, doi: 10.2352/ISSN.2470-1173.2020.2.SDA-265.

[15] H. T. Nim *et al.*, “Design Considerations for Immersive Analytics of Bird Movements Obtained by Miniaturised GPS Sensors.,” in *VCBM*, 2017, pp. 27–31.

[16] C. Jennett *et al.*, “Measuring and defining the experience of immersion in games,” *Int. J. Hum.-Comput. Stud.*, vol. 66, no. 9, pp. 641–661, 2008.

[17] T. Nemoto and D. Beglar, “Likert-scale questionnaires,” in *JALT 2013 conference proceedings*, 2014, pp. 1–8.

[18] “In the Eyes of the Animal.” Accessed: Mar. 02, 2024. [Online]. Available: http://www.iteota.com/

[19] C. Nast, “See like a frog, an owl or a dragonfly in this strange VR video,” *Wired UK*, Sep. 22, 2015. Accessed: Mar. 02, 2024. [Online]. Available: https://www.wired.co.uk/article/virtual-reality-grizedale-forest

[20] M. Mori, K. F. MacDorman, and N. Kageki, “The uncanny valley [from the field],” *IEEE Robot. Autom. Mag.*, vol. 19, no. 2, pp. 98–100, 2012.