Aalborg Universitet

In Search of Alternatives: Co-Designing a Digital Innovation Game With an Indigenous San Community

Chris MuAshekele*
chris@cc.au.dk
Aarhus University
Aarhus, Denmark

Shorty Kandjengo
shortzkadjengoq@gmail.com
Donkerbos Community
Donkerbos, Namibia

Heike Winschiers-Theophilus
hwinschiers@nust.na
Namibia University of Science and Technology
Windhoek, Namibia

Kasper Rodil
kr@create.aau.dk
Aalborg University
Aalborg, Denmark

ABSTRACT

Technology solutions in rural indigenous African contexts are too often grounded in top-down, needs-based development approaches. Participatory methods, such as Community-based Co-Design, oppose such tendencies and emphasise the participation of communities in the technology design process as culturally-situated experts. We extend and reflect on this premise by exploring the sequential co-design of a digital innovation game with a rural indigenous San community in Namibia as a base for alternative indigenous technology design and futuring. Through emerging insights, we note that despite the community's complex and intertwined contemporary status quo resulting from a mix of experiences and interactions, it maintains a pronounced desire and connection with its own culture and traditions. As evidenced by the community's reflections, recollections and constructs during the co-design process, this connection offers new design perspectives that not only counter inapt design concepts but enable alternative technology possibilities grounded in local contexts. Therefore, we argue for its broader consideration within technology endeavours and interventions in indigenous contexts; thereby, enabling a spectrum of local and indigenous innovations.

CCS CONCEPTS

• **Human-centered computing → Empirical studies in HCI**.

KEYWORDS

Co-design, Participatory design, indigenous innovation, San people

1 INTRODUCTION

Within rural indigenous African contexts, communities face a range of issues and challenges such as low income, climate change and sustainable energy transition [3, 11, 23]. Technology solutions have

---

*Research conducted and paper written whilst at Aalborg University, Denmark

been deployed and explored to address these issues [16, 20]. However, in certain instances, these solutions are inappropriate, with little community involvement or input during the various stages of development and implementation. This sets the scene for solutionism and saviourism, with outside "solutions and saviours" aiming and intending to save Africa [1, 37]. Often, this unfolds as a top-down, needs-based development approach, "where technology design is fully envisioned by "experts" and transferred in underdeveloped or marginalised communities with no space for the engagement of end-users in the design process" [22]. Consequently, this perpetuates the mundane reproduction and universality of solutions, with mostly conventional and Western models of progress and technologies espoused [21, 36], and little opportunity or capacity given to local communities to explore alternative solutions and designs, therefore, impeding local innovation.

These communities, custodian to indigenous knowledge and culture, possess ingenious insights and perspectives that are conduits for alternative possibilities [26, 34, 35, 40]. As Philip et al. [39] assert, "indigenous spaces are sites of contestation, cultural innovation, and connection … [and] we should expect to find new forms of technical practices emerging and moving from these spaces." Thus, advancing broader design participation and engagement in such contexts, there have been calls within Participatory Design (PD) and related fields, for "those involved in the design process to imagine and move towards new visions of the future" [45]. In this way, PD, and in particular co-design, become mediums through which local communities can leverage their knowledge, practices and perspectives as part of the design process [22, 30, 48, 53].

Therefore, in this paper we present and explore the co-design of the digital Chameleon Innovation game as a base for alternative indigenous technology design in partnership with an indigenous rural San community in Namibia. Exposing community members to new and emerging technologies, the game aims to foster and enable the ideation of radical and innovative ideas in the community; thereby supporting futuring, a process through which communities explore alternative futures. In the following sections, we delve into futuring, PD and Community-based Co-design, introducing them as guiding theoretical and methodological pillars. Thereafter, we present the co-design of the digital Chameleon Innovation game, detailing its initial emergence as a card game, and the empirical three part design session focusing on its digitisation. In the end, we reflect on the co-design outcomes, applying a critical lens in

appreciation of the community's cultural situatedness considering its intertwined contemporary indigenous context.

2 FUTURING, PARTICIPATORY AND COMMUNITY-BASED CO-DESIGN

Tony Fry [12], in his thought-inducing book, *Design Futuring*, argues that the "Future is by design." This perspective posits a broader and more reflexive consideration of our roles as designers, and of broad society, in futuring. As described by Hoffman et al. [15], futuring refers to the process of imagining the future. In recent times, as a response to ongoing contemporary issues and the need for sustainable and desirable futures, there has been a growing number of design futuring endeavours [31, 32, 47]. Kozubaev et al. [18] outlines design futuring as "an umbrella term to refer (albeit loosely) to a variety of approaches that leverage design to explore futures as a means to comment on—and potentially change—the present." However, futuring tends to exhibit elitist tendencies, mostly applied in privileged and well-resourced contexts [13, 18]. Therefore, contextualising and offering insights into futuring within an African setting, Muashekele et al. [33], conceptualised Community-based Futuring to enable speculative yet grounded futuring practices, aligning them with PD and Community-based Co-design.

PD has long been recognised for its human stance in technology design and development projects [5, 7, 44]. With the underlying ethos of collaboration and inclusivity, PD's transformative agenda (e.g., equity, empowerment, community-building, capacity-building, etc.) makes it visible how research and design are highly entangled and invested in inducing change for good [46]. Over the years, the tension points of technology and people have not disappeared, and the quest for inclusive technology design has seen the methodology of PD adopted and transformed [13]. Where early PD was operationalised in places of work, it has in later years become useful in places where people live [19, 42, 51]. DiSalvo et al. [10] present and advance this evolution as Community-based Participatory Design, emphasising the need to employ and assess "Participatory Design practices across the diverse contexts and issues of communities."

In an African context, the approach has been framed within an Afrocentric research paradigm and Ubuntu philosophy, leading to its re-conceptualisation as Community-based Co-Design (CBCD) [53]. While classic PD usually means collaborating with individuals in a joint cause, CBCD usually means collaborating with groups of people, often indigenous, who have shared values and beliefs [49]. Therefore, the collaborative mechanics have changed to reflect these new contexts, for example, appropriating PD methods to the cultural dynamics [17]. As such, leveraging its community-situatedness and design affordance, CBCD has been recognised and successfully applied across diverse rural African communities to design appropriate and applicable technology solutions [8, 48, 52].

3 PROJECT AND COMMUNITY CONTEXT

This work is situated within a large European Union-funded green energy access project that aims to advance energy solutions and business models across 9 African countries. Within the scope of the project, we acknowledge the challenges of finding alternative ideas to the mundane and mainstream catalogue of technological solutions to African issues. Projects of this nature tend to apply a hierarchical top-down, needs-based development approach. However, opposing this, our role in the project is based on exploring alternative green energy possibilities and uses cases with one of our rural indigenous partner communities in Namibia, Donkerbos.

The community constitutes an estimated 200 Ju/'hoansi speakers, one of the many San tribes in Southern Africa. Traditionally, the community were hunter and gatherer nomads in different clans across the Kalahari Desert. However, due to exploitation and oppressive programs such as colonialism and apartheid, these cultural practices and other culturally relevant activities were suppressed and restricted in favour of 'modern' and other forms of development [14]. Additionally, for many years, encounters with other tribes, contemporary national laws and commercial farm fencing have prohibited their nomadic activities and lifestyle, leading to the gradual loss of their culture. As a result, the community is a mix of many different experiences and influences culminating in the adoption of its current contemporary culture and identity.

Currently, the community is resettled on a farm as part of a national programme which seeks to reintegrate it within the broader society. However, this integration has been restrictive, challenging and primarily top-down, with the community undermined and categorised as marginalised. In the green energy context, integration is based on new notions of sustainability which encroach the remaining cultural anchors, with endorsements for the community to 'leave behind' its traditional practices and structures such as cooking with firewood, building and living in huts, tree harvesting, and 'catch up' by adopting mainstream energy and technology use cases such as irrigation, lighting and water pumping. The community has expressed discontent with the status quo, and in recent years, we have co-designed and partnered with them on various projects aiming to preserve their indigenous knowledge and expand their livelihood. During these projects, the community has often reflected on the status quo, highlighting its desire to be self-determining and self-defining, with the interim community chief (also the community facilitator and co-author) stating,

> "[In the past], we were having our own culture and traditions as San people. We were hunting, it was free for us to hunt. We could gather our field food. Everything was free at that time. We were also having the natural medicine plants that were available. Life was nice, the people lived a very nice life. There were no restrictions or laws that prevented the people from hunting or anything. But since then, while the people were in that process [living traditionally], we encountered another group which I refer to as colonialism. These people when they came attracted these people [the San] with workforce ... creating employment by taking the San people to their farms so that these people [the San] can start to become their farmworkers and so on. Later on, we forget everything [culture and traditions], and some of the stuff, although we did not forget it, we could not make use of it anymore so we left some of the useful traditional and cultural practices that were here [the past] and then we started to live a new lifestyle that we got from these people."

This sentiment, in large part, articulates the community's experiences and interactions, and encompasses its desire for self-determination and self-definition, as well as emphasises its longing to connect with its culture and explore alternative possibilities.

4 LOCALISING THE CHAMELEON INNOVATION GAME AS A DIGITAL APPLICATION THROUGH CO-DESIGN

In the following section, we present the co-design of the Chameleon Innovation game as a digital application. As a background preceding the co-design, we briefly present the initial enactment of Chameleon Innovation Game as a card game and the development of prompt prototypes. Thereafter, we unfold and demonstrate the co-design of the application. In addition to the notes taken in-situ, the co-design session was recorded, and subsequently grouped, transcribed and tagged, providing a post-situ analysis and allowing for reflection and discussion in the ensuing section.

4.1 Chameleon Innovation Game: Exploring alternative possibilities

4.1.1 Chameleon Innovation card game. Cognisant of the community's desire to explore alternative possibilities, in our project we explored various futuring, specifically speculative design methods, such as future-walking [9] and 'what if' [4] with the community as means to imagine innovative technology ideas as part of an alternative green-energy enabled future in which they use green energy based on local and meaningful use cases and technologies. However, due to various factors, such as the community's limited exposure to technology and scepticism, the methods were not entirely effective, with only a few ideas and prompts generated. These ideas and prompts, such as a San flying vulture that the community can use to fly and a San exhibition robot that teaches and showcases the community's traditional culture, were valuable, offering us insight into the community's perspectives, desires and worldview.

Encouraged by the ideas and prompts, albeit few, we developed a card game named Chameleon Innovation game (hereinafter referred to as Chameleon game), as an ideation method to foster additional community ideas by exposing the community to a variety of emerging technologies, and thereafter, combining them with community cultural practices and contemporary resources. The gameplay was set to be random, with groups of paired participants randomly combining a range of cards categorised as indigenous culture, contemporary resources and emerging technology (see figure 1). The randomness caused eccentric combinations, enabling the generation of alternative and innovative technology designs and use cases such as a cultural monitor, which can be used to track the community's cultural activities and ceremonies and a digital fire storyteller that connects and preserves indigenous stories and the practice of storytelling around the fire through a mix of digital and traditional technologies.

The game, comprising four phases, was played across several sessions over two days. Reflecting on the game, some of the participants struggled, despite our descriptions, to grasp and understand the emerging technologies. Thus, they requested additional cards and game features, such as video descriptions and demonstrations of emerging technologies in-situ, which would allow for broader

exposure to and understanding of emerging technologies. Additionally, the participants emphasised their desire to play the game independently of the researchers and have deeper reflections whilst playing. Therefore, we set to incorporate the above requirements into the game by digitising it as a mobile application (hereinafter referred to as Chameleon application) through co-design.

Figure 1: Various Chameleon game cards showing indigenous culture, contemporary resources and emerging technologies

4.1.2 Prompting prototype. Historically and in recent times [6, 25, 41], prototypes have been used in participatory and collaborative design processes as a means to invoke and prompt dialogue during technology design sessions. Therefore, preceding the co-design of the Chameleon application, prototypes were developed to seek a variety of design prompts that could be used by the community as a starting point for the design process. The prototypes were developed as part of a student design challenge, whereby we instructed students (as part of one of the HCI-centric courses we teach) to develop prototypes showcasing emerging technologies based on the cards and the rules of the Chameleon game. Using a variety of community image data, pictorial references and community requirements, the students developed the prototypes with Figma. Compared to the cards in the Chameleon game, the prototypes had features that provided 2D and 3D representations of the emerging technologies to highlight possible use and deployment. Other features included video and audio playback and different interfaces, with some prototypes, as a background, having an aerial view of the community and the surrounding vegetation with kraals and goats (see figure 2).

4.2 Co-designing a community-based Chameleon application

Following the development of the prototypes, we had a co-design session in Donkerbos. The session was split into three parts: 1. *community review and reflections*, with participants reflecting on the Chameleon game and the status quo; 2. *prototype evaluation*, where, as a design prompt, participants evaluated the prototypes from the design challenge; and, 3. *a two-part design activity*, during which the Chameleon application interface was designed and its

Figure 2: Two Prototype interfaces showing various community contemporary elements and emerging technologies such as robots and drones

possibilities explored. Twenty-seven participants, constituting a diverse mix of age groups and technology experience, volunteered to partake in the session, enabling a wide scope for evaluation and design ideas. Before the session, in recognition of our long-term collaboration and community relations, we held an introductory meeting where we exchanged greetings and pleasantries with the community and discussed their overall well-being and status.

4.2.1 Community review and reflection. At the beginning of the session, we reviewed and reflected on the previous sessions where the card version of the Chameleon game was played. During the reflection, the participants laughed as they humorously recalled the game, indicating its complexity and eccentricity. The challenges of the game were highlighted, and thereafter, we explained the development of the prototypes as design prompts to inspire the community towards the co-design of an improved version of the game as a mobile application. We emphasised that similar to the card version, the intent is for the application to support and enable community ideation and futuring. The community facilitator, emphasising the need for community-based ideation, stated: "[the community] can start thinking about new ideas and all the old ideas that were here [in the past] that the [San] people have lost and are not using them anymore but perhaps … if they can bring those ideas to the modern life they can improve their living ways and standards."

Figure 3: On the left, participants discussing and reflecting on the game and community ideation. On the right, participants exploring and evaluating the prototypes

4.2.2 Prototype evaluation. Thereafter, as a precursor and prompt to inspire the design of the Chameleon application interface, the participants evaluated the prototypes. They were split into two groups, with each group receiving a tablet with the prototypes installed. To allow thorough and situated discussions, only the two prototypes that most accurately portrayed the community context were shown (as seen in figure 2). We explored the prototypes with the participants, highlighting the different features and functions. The participants were zealous throughout and showed particular interest in the interface, discussing the various technologies and graphical elements. They recognised technologies explored in previous design endeavours such as robots and drones and easily grasped many of the contemporary icons such as the criss-cross (danger), ear (hearing), cattle, goats and other elements found in the community. However, they placed greater emphasis on the icons and elements representing cultural practices and objects, describing them in detail; for example, explaining how a prominent traditional tree (Magohu) was dug up, cut, split, dried and thereafter used as medicine. At this point, the participants were discussing the various practices and objects, with various exchanges and interpretations expanding the meaning and relevance of the practices and objects in the past and the present.

4.2.3 Chameleon application interface design. Subsequently, the groups gathered to design the Chameleon application, starting with the interface. Overall, the setting was positive and engaging, with the participants indicating their readiness and willingness to design the interface. We explained that they could appropriate and use features from the prototypes as part of the design. Simultaneously, we encouraged them to base the design on their preferences, and scoped the design by briefly demonstrating a drone as an emerging technology reference and focus point.

However, despite earlier explanations, there was some uncertainty amongst participants regarding the type of application to be co-designed. Therefore, using local terms and vernacular, the community facilitator explained to them what an application is. He also showed various applications on his phone, describing what they are and what they do. In addition to this, we shared an explanatory scenario based on the drone with the participants, whereby we asked them, 'If you do not know about the drone or have not seen it before, how would you like for it to be explained to you through an application?' as a prompt question.

Following the prompt, commencing the design of the Chameleon application, the community facilitator said, "I think all the technologies can be attached on the preface of the application." Seeking further elaboration, we probed and asked how this interface looks like. In response, the facilitator said, "According to my understanding, this is now a picture (showing the background interface of one of the prototypes) of the normal (contemporary) life of the [San] people … here we are having things like cattle, and cattle in the Ju'hoansi tradition was not part of their lives, so if we can perhaps have [wild] animals." He argued that the application should be situated within their culture and tradition instead of their current contemporary lifestyle. The other participants agreed fully and endorsed the idea, and thereafter, using different colour markers and chart paper, they sketched the interface of the application starting with a Kudu (a wild antelope found in Southern Africa) as the first icon for the Chameleon application.

Afterwards, we asked about the context and correlation of the Kudu to the application. Similar to the earlier pronouncement by the community facilitator, the participants pointed at a kraal in one of the prototypes and explained that instead of having domesticated animals such as cattle and goats in a kraal they prefer the interface with wild animals (such as the Kudu) which represent their culture and how they used to live in the past. At this point, the participants were immersed in the design process with discussions and inclinations for culture and tradition as the main interface elements. Assertively, the participants, preferring an interface based on their culture and traditional practices, insisted that they do not want an interface based on contemporary constructs such as the fence (representing the current community boundary) shown in one of the prototypes.

To further extend the design of the application and clarify the function of the Kudu icon, we probed further asking what happens when it is clicked. The participants, signalling for cultural references associated with the Kudu to be shown, explained that the application will have different layers, which include a second page providing a descriptive visualisation of the Kudu that would pop up. The description would be categorised according to the different parts of the Kudu, such as its head, body and tail. This categorisation, the community facilitator, actively contributing to the discussion, explained, would enable a high-level yet in-depth description of the Kudu's cultural use and the different innovative and traditional products made out of it, such as its horns, leather and organic fertiliser. Thus, allowing the community, particularly the younger generation, to learn about and understand the Kudu, and broadly their culture, and the possibilities it offers.

4.2.4 Chameleon application possibilities. Seeking to extend the interface design and align it with emerging technologies, we asked how an emerging technology, such as the drone we showed earlier, can be linked to the Kudu. Several possibilities were suggested; for instance, drone hunting, with one participant highlighting the drone's mobility and function, stating, "if you want to know which direction the animals are at, you can take this stuff (the drone) that can go 2 or 3 kilometres or further … you can spot a direction of an animal, in which direction it is and then you can just go there." We asked how drone hunting should be represented on the interface.

The drone was denoted as an eye, which, when clicked, as one participant explained, "means you want to send it to spy the environment." This function expands the application, ensuring that it not only demonstrates and describes various cultural items such as the Kudu but also serves as a portal through which community members can control and operate different technologies across different scenarios, as is the case with the drone, enabling its use across different use cases. Besides the spy function, other drone use cases and activities were suggested. These were denoted as icons, such as a red cross which represents the use of the drone for health and medical purposes. An arrow icon was suggested to represent collection, transportation, and other auxiliary drone use cases. A wrench icon was also added to represent the use of the drone for the collection of any parts or utilities that the community needs.

To finalise the interface, additional icons specific to cultural practices were added, such as a hut, which, when clicked, showcases traditional activities such as dancing. They further suggested and

sketched a bow-and-an-arrow icon which, in addition to the Kudu icon, represents hunting but across a wider range of wildlife. A tortoise shell which is used to store a special powder that is used to welcome visitors was also added. One of the participants explained that applying the powder on visitors is a ceremonial welcome. Linking the drone to the tortoise shell, we asked, as a prompt, if a drone could be used to welcome visitors (with the powder and water) as they walked towards the village. The participants, resonating with the idea, enthusiastically emphasised its possibility and ingenuity. Thereafter, concluding the session, we thanked the participants and encouraged them to continuously think of additional features for the application.

Figure 4: On the left, a participant sketching the Chameleon application interface. On the right, the Chameleon Innovation application interface design indicating a Kudu and various other icons. The sketch, seemingly basic, represents the community's design and visual preferences based mostly on its indigenous practices, countering constrictive contemporary elements and narrative as shown in the prototypes.

5 CULTURAL SITUATEDNESS WITHIN AN INTERTWINED CONTEMPORARY INDIGENOUS CONTEXT

As part of its more matured stance for inclusion and diversity, PD, operationalised through co-design, has become a proponent for the embodiment of diverse cultures and plural technology design [28, 38, 50, 54, 55]. As per this stance, it has evolved from its traditional workplace narrative and taken on a 'community-based' disposition with emphasis on culture and development [24, 29, 43]. This, in large part, has been through the illumination of a wider range of perspectives infusing design with "elements that sustain a communities' values, practices, and culture" [2]. Essentially, these elements, as design objects echoing local knowledge, perspectives and practices, "are embedded in culture and are always reaching out to various cultural contexts incorporating different dimensions and resonances of meaning" [27]. Similarly, this stance is echoed within futuring, with Muashekele et al. [31] arguing for a broader inclusion of community perspectives in speculative practices; thus, opening up new technology and social possibilities.

As per the above sentiments, the essence of culture within design and futuring is conspicuous and significant. However, as emphasised by the participants in Donkerbos, their culture has been suppressed in favour of other forms and orientations of being. Thus, the co-design was subject to the participants' desire to culturally situate and localise the Chameleon application. This was evident through the inclusion and emphasis of the Kudu as an icon due to its cultural significance, as opposed to cattle and goats which are contemporary. However, we recognise that within the current contemporary parameters, many of the cultural community practices are not practised and cannot be practised, at least not to the same degree as in the past. Rather, the community is situated in a contemporary status achieved through accumulated and mixed experiences and interactions with oppressive programmes, national laws, government, NGOs, other tribes, researchers, etc. This amalgamation of experiences, which are complex and intertwined, was brought into the co-design. For instance, drone hunting was suggested as an alternative technology use case, but a significant part of traditional hunting is trekking, with a hunter expertly knowing and following animal footprints, reading the wind, mastering approach and more. As such, applying a critical lens, the introduction of the drone as an emerging technology and future use case does not take into account how it might negatively impact and impede the cultural essence and values embedded in hunting. Thus, the relativity and amalgamation of cultural practices and technology have to be carefully assessed and considered during the design process.

Essentially, for the above assessment, a deeper reflection on the technological transformation and transition in the community is required, taking into account that the community members are indigenous yet do not live indigenously. However, this is a complex paradox requiring a balanced assimilation of their cultural practices, and at the same time exploring alternative technological possibilities that may advance or hinder culture. This calls into question what type of futures, and technologies as part of these futures, do we want. Thus, we argue that the co-design process should be attuned and introduce new technologies as external artefacts requiring collaborative, yet delicate, explorations to appropriate them within indigenous community contexts; and simultaneously, be a space for cultural resurgence. As part of the Chameleon application co-design process, we explored prototypes as design prompts to inspire design ideas. Although developed outside the community, the prototypes were effective in enabling the participants to reflect and articulate what they wanted and did not want. For instance, the participants placed emphasis on cultural objects and practices as primary elements for the Chameleon application interface. However, as some of these practices are inactive - they remain imagined and embedded in folklore, and therefore may be subject to new adaptations and meaning. On the one hand, this may be advantageous, providing alternative design and technology possibilities, as well as new community constructs, as is the case with the Chameleon application interface sketch which counter constrictive contemporary elements and narratives. On the other hand, without reflection, this may lead to the degradation of remaining cultural practices. Therefore, as we imagine new visions of the future, how do we find the necessary balance? This question, we posit, serves as a

guiding compass, offering new ideas and possibilities for African researchers, projects and communities.

6 CONCLUSION

Opposing hierarchical and top-down technology development approaches, participatory approaches such as Community-based Co-design (CBCD) situate the design process within the local community context in an effort to design appropriate technology. Therefore, in this paper, we present and explore the co-design of a digital innovation game with a rural indigenous San community in Namibia as a base for alternative indigenous technology design. Specifically, the game serves as an ideation method which supports futuring endeavours in the community by exposing community members to new technologies, and as per their own design constructs, their own culture. During its co-design, the participants opposed contemporary design elements, with an inclination to cultural practices and objects as relevant interface elements. The community's preferences, despite their complex and intertwined contemporary status quo resulting from a mix of experiences and interactions, illustrate a pronounced connection and desire to its own culture, offering a lever for community innovations in the form of alternative technology possibilities and futures grounded in the local context. Therefore, we posit that the above connection and desire should be embraced and encouraged within African design contexts, serving as a pathway for African innovation.

ACKNOWLEDGMENTS

REFERENCES

[1] Muhammad Sadi Adamu. 2022. No More 'Solutionism' or 'Saviourism' in Futuring African HCI: A Manyfesto. *ACM Trans. Comput.-Hum. Interact.* (nov 2022). https://doi.org/10.1145/3571811
[2] Maria J. Anderson-Coto, Julie Salazar, John Louis-Strakes Lopez, R. Mishael Sedas, Fabio Campos, Andres S. Bustamante, and June Ahn. 2024. Towards culturally sustaining design: Centering community's voices for learning through Participatory Design. *International Journal of Child-Computer Interaction* 39 (2024), 100621. https://doi.org/10.1016/j.ijcci.2023.100621
[3] Florent Baarsch, Jessie R. Granadillos, William Hare, Maria Knaus, Mario Krapp, Michiel Schaeffer, and Hermann Lotze-Campen. 2020. The impact of climate change on incomes and convergence in Africa. *World Development* 126 (2020), 104699. https://doi.org/10.1016/j.worlddev.2019.104699
[4] Laura Barendregt and Nora S. Vaage. 2021. Speculative Design as Thought Experiment. *She Ji: The Journal of Design, Economics, and Innovation* 7, 3 (2021), 374–402. https://doi.org/10.1016/j.sheji.2021.06.001
[5] Claus Bossen, Christian Dindler, and Ole Sejer Iversen. 2016. Evaluation in participatory design: a literature survey. In *Proceedings of the 14th Participatory Design Conference: Full Papers - Volume 1* (Aarhus, Denmark) *(PDC '16)*. Association for Computing Machinery, New York, NY, USA, 151–160. https://doi.org/10.1145/2940299.2940303
[6] John Bowers and James Pycock. 1994. Talking through design: requirements and resistance in cooperative prototyping. In *Conference Companion on Human Factors in Computing Systems* (Boston, Massachusetts, USA) *(CHI '94)*. Association for Computing Machinery, New York, NY, USA, 221. https://doi.org/10.1145/259963.260388
[7] Jørn Braa. 1996. Community-based Participatory Design in the Third World. In *Proceedings of the Participatory Design Conference*, Vol. 4. 15–24.
[8] Rumbidzai Chitakunye, Heike Winschiers-Theophilus, Vera De Cauwer, and Sebastian Mukumbira. 2024. Developing an ethnobotanical application with and

for Ovahimba communities. In *Proceedings of the 4th African Human Computer Interaction Conference* (<conf-loc>, <city>East London</city>, <country>South Africa</country>, </conf-loc>) *(AfriCHI '23)*. Association for Computing Machinery, New York, NY, USA, 170–179. https://doi.org/10.1145/3628096.3629053

[9] Simran Chopra, Rachel E Clarke, Adrian K Clear, Sara Heitlinger, Ozge Dilaver, and Christina Vasiliou. 2022. Negotiating sustainable futures in communities through participatory speculative design and experiments in living. In *Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems* (<conf-loc>, <city>New Orleans</city>, <state>LA</state>, <country>USA</country>, </conf-loc>) *(CHI '22)*. Association for Computing Machinery, New York, NY, USA, Article 334, 17 pages. https://doi.org/10.1145/3491102.3501929

[10] Carl DiSalvo, Andrew Clement, and Volkmar Pipek. 2012. Participatory design for, with, and by communities. *International handbook of participatory design* (2012), 182–209.

[11] Ronald Djeunankan, Sosson Tadadjeu, and Brice Kamguia. 2024. Linking energy poverty and industrialization: Empirical evidence from African countries. *Energy* 292 (2024), 130374. https://doi.org/10.1016/j.energy.2024.130374

[12] Tony Fry. 2009. Design futuring. *University of New South Wales Press, Sydney* (2009), 71–77.

[13] Christina Harrington, Sheena Erete, and Anne Marie Piper. 2019. Deconstructing Community-Based Collaborative Design: Towards More Equitable Participatory Design Engagements. *Proc. ACM Hum.-Comput. Interact.* 3, CSCW, Article 216 (nov 2019), 25 pages. https://doi.org/10.1145/3359318

[14] Robert Karl Hitchcock, Megan Biesele, and Wayne Babchuk. 2009. Environmental anthropology in the Kalahari: Development, resettlement, and ecological change among the San of Southern Africa. *vis-à-vis: Explorations in Anthropology* 9, 2 (2009).

[15] Jesse Hoffman, Peter Pelzer, Loes Albert, Tine Béneker, Maarten Hajer, and Astrid Mangnus. 2021. A futuring approach to teaching wicked problems. *Journal of Geography in Higher Education* 45, 4 (2021), 576–593.

[16] Eugene C.X. Ikejemba and Peter C. Schuur. 2020. The empirical failures of attaining the societal benefits of renewable energy development projects in Sub-Saharan Africa. *Renewable Energy* 162 (2020), 1490–1498. https://doi.org/10.1016/j.renene.2020.08.052

[17] Gereon Koch Kapuire, Heike Winschiers-Theophilus, Colin Stanley, Shilumbe Chivuno-Kuria, Kasper Rodil, McAlbert Katjivirue, and Ernest Tjitendero. 2014. Community-based co-design in Okomakuara a contribution to 'design in the wild'. In *Proceedings of the 13th Participatory Design Conference: Short Papers, Industry Cases, Workshop Descriptions, Doctoral Consortium Papers, and Keynote Abstracts - Volume 2* (Windhoek, Namibia) *(PDC '14)*. Association for Computing Machinery, New York, NY, USA, 207–208. https://doi.org/10.1145/2662155.2662204

[18] Sandjar Kozubaev, Chris Elsden, Noura Howell, Marie Louise Juul Søndergaard, Nick Merrill, Britta Schulte, and Richmond Y Wong. 2020. Expanding modes of reflection in design futuring. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*. 1–15.

[19] Bram Kreuger and Tariq Zaman. 2023. Exploring Indigenous Knowledge Through Virtual Reality: A Co-Design Approach with the Penan Community of Long Lamai. In *IFIP Conference on Human-Computer Interaction*. Springer, 439–448.

[20] Ganesh Kumar, Carole Engle, and Craig Tucker. 2018. Factors driving aquaculture technology adoption. *Journal of the world aquaculture society* 49, 3 (2018), 447–476.

[21] Renata M. Leitão. 2022. From Needs to Desire: Pluriversal Design as a Desire-Based Design. *Design and Culture* 14, 3 (2022), 255–276. https://doi.org/10.1080/17547075.2022.2103949 arXiv:https://doi.org/10.1080/17547075.2022.2103949

[22] Gary Loh Chee Wyai, Tariq Zaman, and Khairuddin Ab Hamid. 2022. Unleashing Indigenous Iban Values For Collective Technology Design. In *Proceedings of the Participatory Design Conference 2022 - Volume 2* (Newcastle upon Tyne, United Kingdom) *(PDC '22)*. Association for Computing Machinery, New York, NY, USA, 39–46. https://doi.org/10.1145/3537797.3537806

[23] Sarah Alobo Loison. 2015. Rural Livelihood Diversification in Sub-Saharan Africa: A Literature Review. *The Journal of Development Studies* 51, 9 (2015), 1125–1138. https://doi.org/10.1080/00220388.2015.1046445 arXiv:https://doi.org/10.1080/00220388.2015.1046445

[24] Maria Rosa Lorini, Amalia Sabiescu, and Nemanja Memarovic. 2017. Collective digital storytelling in community-based co-design projects. An emergent approach. *The Journal of Community Informatics* 13, 1 (2017).

[25] Kim Halskov Madsen and Peter H. Aiken. 1993. Experiences using cooperative interactive storyboard prototyping. *Commun. ACM* 36, 6 (jun 1993), 57–64. https://doi.org/10.1145/153571.163268

[26] ST Mahwasane, L Middleton, and N Boaduo. 2013. An ethnobotanical survey of indigenous knowledge on medicinal plants used by the traditional healers of the Lwamondo area, Limpopo province, South Africa. *South African Journal of Botany* 88 (2013), 69–75.

[27] Henry Mainsah and Andrew Morrison. 2014. Participatory design through a cultural lens: insights from postcolonial theory. In *Proceedings of the 13th Participatory Design Conference: Short Papers, Industry Cases, Workshop Descriptions, Doctoral Consortium Papers, and Keynote Abstracts - Volume 2* (Windhoek, Namibia) *(PDC '14)*. Association for Computing Machinery, New York, NY, USA,

83–86. https://doi.org/10.1145/2662155.2662195

[28] Bruno Marques, Greg Grabasch, and Jacqueline McIntosh. 2021. Fostering Landscape Identity Through Participatory Design With Indigenous Cultures of Australia and Aotearoa/New Zealand. *Space and Culture* 24, 1 (2021), 37–52. https://doi.org/10.1177/1206331218783939 arXiv:https://doi.org/10.1177/1206331218783939

[29] Uariaike Mbinge, Colin Stanley, Immanuel Kandjabanga, Chris Muashekele, Kahuhu Alphons Koruhama, Gereon Koch Kapuire, Donovan Maasz, and Heike Winschiers-Theophilus. 2025. Co-creating digital representations of indigenous knowledge: an ovaHimba curated digital repository. *International Journal on Digital Libraries* 26, 1 (2025), 7.

[30] Chris Muashekele. 2018. Technology appropriation through co-design of conservation management tools by indigenous communities. In *Proceedings of the Second African Conference for Human Computer Interaction: Thriving Communities* (Windhoek, Namibia) *(AfriCHI '18)*. Association for Computing Machinery, New York, NY, USA, Article 39, 4 pages. https://doi.org/10.1145/3283458.3283497

[31] Chris Muashekele, Kasper Rodil, Heike Winschiers-Theophilus, and Shorty Kandjengo. 2024. Recovering lost futures of the past: Situating alternative futures within an indigenous Afrocentric orientation and past trajectory. In *Proceedings of the Participatory Design Conference 2024: Full Papers-Volume 1*. 28–40.

[32] Chris Muashekele, Kasper Rodil, Heike Winschiers-Theophilus, and Christof Magoath. 2023. Futuring from an indigenous community stance: projecting temporal duality from the past into the future. In *Extended Abstracts of the 2023 CHI Conference on Human Factors in Computing Systems*. 1–7.

[33] Chris Muashekele, Heike Winschiers-Theophilus, Kasper Rodil, and Uariaike Mbinge. 2024. Infusing Futuring into Community-based Co-design: A Pathway to Innovative Technology Design with Indigenous Communities in Africa. In *Proceedings of the 4th African Human Computer Interaction Conference* (<conf-loc>, <city>East London</city>, <country>South Africa</country>, </conf-loc>) *(AfriCHI '23)*. Association for Computing Machinery, New York, NY, USA, 151–161. https://doi.org/10.1145/3628096.3629049

[34] Chris Muashekele, Heike Winschiers-Theophilus, Kasper Rodil, Colin Stanley, and Hina MuAshekele. 2022. The Chronicles of Kunene: The Lion, the Omuhimba and the Drone. In *Innovation Practices for Digital Transformation in the Global South: IFIP WG 13.8, 9.4, Invited Selection*. Springer, 149–164.

[35] Sebastian Mukumbira, Heike Winschiers-Theophilus, Chris Muashekele, Rumbidzai Chitakunye, Peter Wandai, and Vera De Cauwer. 2021. Conservation tool design caught in the midst of transdisciplinary negotiations of data accuracy. In *3rd African Human-Computer Interaction Conference: Inclusiveness and Empowerment* (Maputo, Mozambique) *(AfriCHI 2021)*. Association for Computing Machinery, New York, NY, USA, 22–32. https://doi.org/10.1145/3448696.3448699

[36] Sabelo J Ndlovu-Gatsheni. 2013. The entrapment of Africa within the global colonial matrices of power: Eurocentrism, coloniality, and deimperialization in the twenty-first century. *Journal of Developing Societies* 29, 4 (2013), 331–353.

[37] Polly Pallister-Wilkins. 2021. Saving the souls of white folk: Humanitarianism as white supremacy. *Security Dialogue* 52, 1_suppl (2021), 98–106. https://doi.org/10.1177/09670106211024419 arXiv:https://doi.org/10.1177/09670106211024419

[38] Dorian Peters, Susan Hansen, Jenny McMullan, Theresa Ardler, Janet Mooney, and Rafael A. Calvo. 2018. "Participation is not enough": towards indigenous-led co-design. In *Proceedings of the 30th Australian Conference on Computer-Human Interaction* (Melbourne, Australia) *(OzCHI '18)*. Association for Computing Machinery, New York, NY, USA, 97–101. https://doi.org/10.1145/3292147.3292204

[39] Kavita Philip, Lilly Irani, and Paul Dourish. 2012. Postcolonial Computing: A Tactical Survey. *Science, Technology, & Human Values* 37, 1 (2012), 3–29. https://doi.org/10.1177/0162243910389594 arXiv:https://doi.org/10.1177/0162243910389594

[40] Maren Radeny, Ayal Desalegn, Drake Mubiru, Florence Kyazze, Henry Mahoo, John Recha, Philip Kimeli, and Dawit Solomon. 2019. Indigenous knowledge for seasonal weather and climate forecasting across East Africa. *Climatic Change* 156 (2019), 509–526.

[41] Apoorva Reddy, Corey A. Lester, Jamie A. Stone, Richard J. Holden, Cynthia H. Phelan, and Michelle A. Chui. 2019. Applying participatory design to a pharmacy system intervention. *Research in Social and Administrative Pharmacy* 15, 11 (2019), 1358–1367. https://doi.org/10.1016/j.sapharm.2018.11.012

[42] Pedro Reynolds-Cuéllar and Daniela Delgado Ramos. 2020. Community-Based Technology Co-Design: Insights on Participation, and the Value of the "Co". In *Proceedings of the 16th Participatory Design Conference 2020 - Participation(s) Otherwise - Volume 1* (Manizales, Colombia) *(PDC '20)*. Association for Computing Machinery, New York, NY, USA, 75–84. https://doi.org/10.1145/3385010.3385030

[43] Kasper Rodil, Shorty Kandjengo, Donovan Maasz, Hasib Ahsan, and Lars Rune Christensen. 2024. Comparative Insights for Community-Based Co-design: Bi-directional Inclusive Strategies Between Marginalised Communities and Researchers in Participatory Design. In *Proceedings of the Participatory Design Conference 2024: Exploratory Papers and Workshops-Volume 2*. 207–210.

[44] Dan Shapiro. 2005. Participatory design: the will to succeed. In *Proceedings of the 4th Decennial Conference on Critical Computing: Between Sense and Sensibility* (Aarhus, Denmark) *(CC '05)*. Association for Computing Machinery, New York, NY, USA, 29–38. https://doi.org/10.1145/1094562.1094567

[45] Jesper Simonsen and Toni Robertson. 2012. *Routledge international handbook of participatory design.* Routledge.

[46] Rachel Charlotte Smith and Ole Sejer Iversen. 2018. Participatory design for sustainable social change. *Design Studies* 59 (2018), 9–36. https://doi.org/10.1016/j.destud.2018.05.005 Participatory Design.

[47] Robert Soden, Pradnaya Pathak, and Olivia Doggett. 2021. What we speculate about when we speculate about sustainable HCI. In *Proceedings of the 4th ACM SIGCAS Conference on Computing and Sustainable Societies.* 188–198.

[48] Fiona Ssozi-Mugarura, Edwin Blake, and Ulrike Rivett. 2016. Supporting community needs for rural water management through community-based co-design. In *Proceedings of the 14th Participatory Design Conference: Full Papers - Volume 1* (Aarhus, Denmark) *(PDC '16).* Association for Computing Machinery, New York, NY, USA, 91–100. https://doi.org/10.1145/2940299.2940311

[49] Colin Stanley, Heike Winschiers-Theophilus, Edwin Blake, Kasper Rodil, and Gereon Koch Kapuire. 2015. Ovahimba community in Namibia ventures into crowdsourcing design. (2015).

[50] Jennyfer Lawrence Taylor, Alessandro Soro, and Margot Brereton. 2018. New literacy theories for participatory design: lessons from three design cases with Australian Aboriginal communities. In *Proceedings of the 15th Participatory Design Conference: Full Papers - Volume 1* (Hasselt and Genk, Belgium) *(PDC '18).* Association for Computing Machinery, New York, NY, USA, Article 11, 13 pages. https://doi.org/10.1145/3210586.3210588

[51] Jennyfer Lawrence Taylor, Wujal Wujal Aboriginal Shire Council Wujal Wujal Aboriginal Shire Council, Alessandro Soro, and Margot Brereton. 2022. Tangible 'Design Non-Proposals' for Relationship Building in Community-Based Co-Design Projects. In *Proceedings of the Participatory Design Conference 2022 - Volume 1* (Newcastle upon Tyne, United Kingdom) *(PDC '22).* Association for Computing Machinery, New York, NY, USA, 63–74. https://doi.org/10.1145/3536169.3537780

[52] Sarina Till, Jaydon Farao, Toshka Lauren Coleman, Londiwe Deborah Shandu, Nonkululeko Khuzwayo, Livhuwani Muthelo, Masenyani Oupa Mbombi, Mamare Bopane, Molebogeng Motlhatlhedi, Gugulethu Mabena, Alastair Van Heerden, Tebogo Maria Mothiba, Shane Norris, Nervo Verdezoto Dias, and Melissa Densmore. 2022. Community-based Co-design across Geographic Locations and Cultures: Methodological Lessons from Co-design Workshops in South Africa. In *Proceedings of the Participatory Design Conference 2022 - Volume 1* (Newcastle upon Tyne, United Kingdom) *(PDC '22).* Association for Computing Machinery, New York, NY, USA, 120–132. https://doi.org/10.1145/3536169.3537786

[53] Heike Winschiers-Theophilus, Tariq Zaman, and Colin Stanley. 2019. A classification of cultural engagements in community technology design: introducing a transcultural approach. *Ai & Society* 34 (2019), 419–435.

[54] Penny Hagen Yoko Akama and Desna Whaanga-Schollum. 2019. Problematizing Replicable Design to Practice Respectful, Reciprocal, and Relational Co-designing with Indigenous People. *Design and Culture* 11, 1 (2019), 59–84. https://doi.org/10.1080/17547075.2019.1571306 arXiv:https://doi.org/10.1080/17547075.2019.1571306

[55] Tariq Zaman and Alvin Yeo Wee. 2014. *Ensuring Participatory Design Through Free, Prior and Informed Consent: A Tale of Indigenous Knowledge Management System.* Springer International Publishing, Cham, 41–54. https://doi.org/10.1007/978-3-319-05963-1_4