Design Education Forum of Southern Africa

Vulindlela – making new pathways

17th DEFSA conference – 21|22 September 2023

Decolonising speculative design: A South African perspective on design and futures thinking

Hadassah Myers, University of Johannesburg

Abstract

Speculative design is being promoted as a critical approach to design. Speculative design does not attempt to predict the future. Instead, it attempts to create debate and discussion about preferable futures (Dunne & Raby 2013). Design educators and practitioners from the Global South have become increasingly critical of speculative design practices (Martins 2014). This paper provides an account of a speculative design project set for final-year students pursuing a degree in Digital Media Design at the University of Johannesburg, South Africa. The paper describes the project brief, the purpose of the assignment and the intended outcomes. Three student designs are presented and explored using a textual analysis methodology. The paper then draws on Anticipatory Systems Theory to unpack how Speculative Design education and practice can be augmented with alternative approaches the way Futures are used.

Keywords: Anticipatory design, decolonisation, speculative design.

Introduction

Tharp and Tharp outline four motives of design practice. Design for: 1) profit, 2) emancipation, 3) experimentation, and 4) discussion and reflection (Tharp & Tharp 2018). As such, Design Education should touch on all these domains. One of the central units in the Digital Media Design third-year course at the University of Johannesburg, South Africa focuses specifically on speculative design (SD). Students spend a semester learning about SD and working on a design project for the purpose of communication and reflection. Over the course of the semester, students attend weekly lectures and group sessions. They are introduced to the theory and practice of SD. Existing projects created by other designers are showcased and discussed. Students are then divided into groups. They are asked to think about a contemporary problem facing humanity and imagine what that might look like in fifty years' time. They must conceptualise and design an artefact that makes use of speculative technology. The artefact must describe this imagined future with the intention of invoking discussion about the issue they wish to reflect on. The final outcome of this project is a short film or video featuring the artefact and the scenario in which it is being used.

One of the intentions of running this project is that it may contribute to the practice of SD in the Global South. As a lecturer overseeing this unit, I noticed that while the quality of work produced was of an excellent standard, the outcomes were no different to the SD projects coming out of the Global North. In an attempt to address this issue, the project that ran during the 2022 academic year was tweaked

© Copyright 2023 Design Education Forum of Southern Africa (www.defsa.org.za)

slightly and stipulated that the speculative scenario and artefact must address a local South African contemporary problem. Examples were issues such as corruption, load shedding, fees must fall, xenophobia, etc. It was exciting to see how students used their own local context to create SD artefacts. Unfortunately, for all intents and purposes, the project's final output did not change much. The imagined future scenarios and artefacts were a regurgitation of “used futures”. The only difference was that the scenes were set in South Africa. “Used Futures” is a term used to describe second-hand futures that inadvertently borrow possible and preferable futures imported from a foreign culture seen as worldly superior (Kwazema 2021; Sheraz, Inayatullah & Shah 2013; Sheraz 2021).

Speculative design and the future

SD does not propose to predict the future. It is a form of design that is provocative in an attempt to unsettle the present. In theory, it is a space to discuss the future before it happens as a way to avoid undesirable futures. It is a critical practice in that it highlights social, cultural, ethical, and political issues and offers alternative possibilities for our technologically mediated lives (Dunne & Raby 2013). Critical design movements try to employ critique as a means of bringing about change from within design.

Criticism has been levelled at SD for having Anglo-European biases in assumptions about the past and future (Mareis, Greiner-Petter & Renner 2022). Some of the issues brought up by scholars from the Global South point to the dystopian narratives that usually unravel in what is clearly a privileged Global North landscape. The cautionary tales of the future are the past and even the current reality of much of the world's population. The technology featured has only ever been accessible to the privileged (Prado & Oliveira 2014).

Design students in South African universities are predominantly educated through an epistemological standpoint from the Global North. This pedagogy forces the majority of students to view the world and themselves with dual identities – that of their own and that of the other (Ambala 2021). SD creates discussion about the present quite well by using the future to discuss a desirable or non-desirable future. It is not good at looking backwards for inspiration and, therefore, finds it challenging to present emerging futures that draw inspiration from the people, philosophies, and designs of Africa and its diaspora (Ambala 2021). Ideas about development, science, culture, and technology are framed through a Global North lens, and the notion of this vision of the future runs the risk of becoming epistemological colonialism (Fry 2017).

This paper suggests that anticipatory assumptions can "colonise" the future based on the forms of extrapolation that are used to prepare for the future (Miller, Poli & Rossel 2013). The paper showcases and explores three student projects. The projects are described in detail. The paper then employs a textual analysis through the theoretical lens of Anticipatory Systems (AS). AS is a theory of how complex systems function and adapt. It explains the mechanisms that facilitate dynamic agility in living systems. AS is non-deterministic and asserts that systems are not made up of a collection of individual elements. Systems are seen as relational models that have an inbuilt sense of self and non-self and embedded knowledge of past and future states (Rosen, J. 2022). AS Theory will help establish the role biases and assumptions play in anticipating the future. AS approaches will be proposed as a method for minimising the Global North biases that underpin speculative design education and practice.

© Copyright 2023 Design Education Forum of Southern Africa (www.defsa.org.za)

Speculative design projects

Project 1: The Bubble

The Bubble is a speculative artefact from the future. It is introduced through an animated film that serves as a cautionary tale of what might happen within the sphere of energy production in South Africa should things not change dramatically. It alludes to the current energy crisis in South Africa, the looming climate disaster, and the technological developments within these spheres. The Bubble is intended to invoke a discussion about the broad class and wealth disparity in South Africa.

The Scenario

The year is now 2072. South Africa is still mining and using coal as its primary source of electricity production. Energy is also produced for export, making the rich richer and creating a wider gap between the rich and poor. Energy production methods have caused an escalation of extreme climate change. It has reached a point where the air is no longer safe to breathe. Infrastructure has collapsed, and there are no longer natural resources such as water and plants.

The Artefact

The speculative artefact (Figure 1) is a "bubble". The Bubble is an artificial environment that gives people of means (the rich) a way to escape the consequences of years of corruption and greed. The Bubble protects its citizens from the devastating effects of climate change.

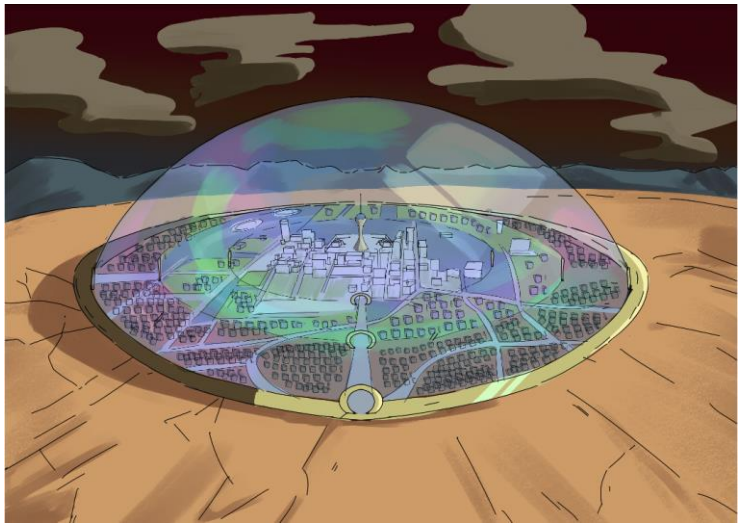

Figure 1: The Bubble

Outside the Bubble

The poor working class live outside the Bubble (Figure 2). They are left to eke out a meagre living by mining coal and working in an energy production facility. Most people capable of working do so in facilities that provide the power for the upkeep of the Bubble. Their meals are limited to one a day, and their electricity to 2/3 hours a day. Air quality is so bad that everyone must wear gas masks outside their houses.

Figure 2: Life outside the Bubble

Inside the Bubble (Figure 2)

There are three zones in the Bubble. Each zone is allocated to residents of The Bubble based on their class and wealth status.

Outer circle: The people living in the outer circle of the Bubble are physical labourers. Their jobs are for the upkeep of the Bubble. These are the street-sweepers, janitors, builders and the like. Workers can travel to other parts of the Bubble to work but cannot overstay a set number of hours. The air quality within this section is better than outside the Bubble – but not perfect. People are still required to wear masks at certain times when the smog is too much. They have access to more electricity – 5/6 hours a day – and have a bigger food allowance than people living outside the Bubble.

Middle circle: The upper-middle-class citizens live in this ring. They are generally professionals such as teachers, doctors, and engineers that maintain the infrastructure of the Bubble. Crops are grown in this circle. There are no food restrictions, and air quality is good enough that masks are not required at all. This section has electricity for 15/18 hours a day.

Inner circle: The wealthy elite and politicians reside here. There are no food or electricity restrictions in this circle. This circle has the clearest air, the best technology, and the greenest environment.

Figure 3: Life inside the Bubble

© Copyright 2023 Design Education Forum of Southern Africa (www.defsa.org.za)

The functionality of the artefact

The Bubble uses advanced Internet of Things (IoT) technology to reduce greenhouse gasses in a set area. It reintroduces oxygen and clean, breathable air into the Bubble and blocks out harmful UV rays. It has a temperature control system that cools the area around the Bubble based on sensor input. Technicians use a digital interface to monitor the environment and adjust settings when needed (Figure 4 and 5).

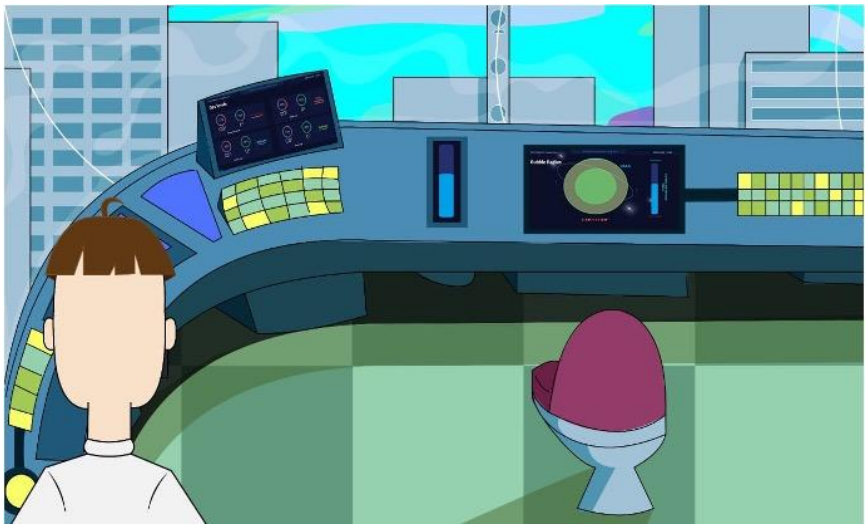

Figure 4: Technicians interacting with the digital interface

Figure 5: Digital interface

The final short film can be viewed on the following URL: <https://youtu.be/h77osuDt81s>

Project 2: Android police force

This project sets out to discuss the collapse of law and order and police brutality that emerged with the spike in protest action following the COVID-19 pandemic and the ensuing recession. Dissatisfaction with service delivery and anger at government corruption caused a rise in both legal and illegal protests. Violence, looting, and rioting became a common occurrence, and it was difficult for the police

to control the situation. Technology played a leading role in many instances Media captured live footage with drones, and on one occasion, a group of journalists were even attacked.[1] The project explores the complex double-edged sword technology wields by imagining a speculative future in which chaos is created and then stifled by technology.

The Scenario

It is 2072. Illegal protesting has reached dangerous proportions. Average citizens have easy access to advanced weaponry. The disruption has made governing very difficult. The South African government has launched a crime prevention programme using IoT technology. Drones and android killing machines can be activated in severe circumstances to prevent and stop protests (Figure 6). The response unit is strictly shoot-to-kill and can be activated by the president using biometric access control technology. This procedure can only be initiated by the cabinet. The president is the only one who can access the device controlling the search and kill network.

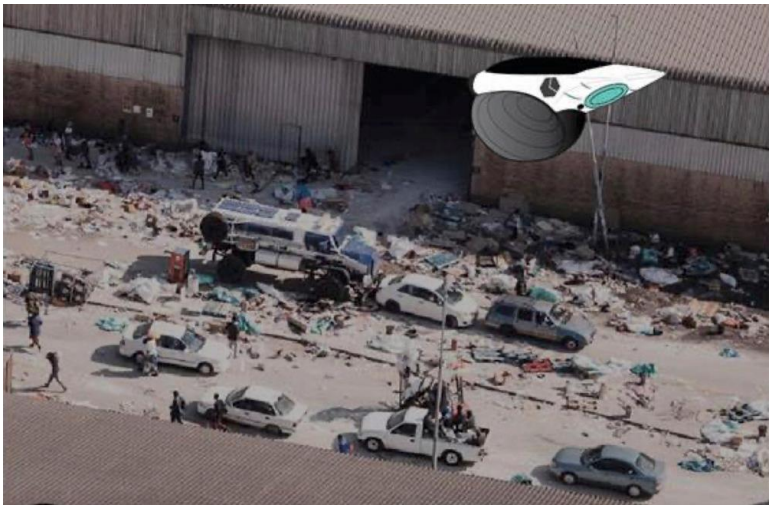

Figure 6: Crime prevention system

The Artefact

The artefact is a connected system of artefacts. Android soldiers form an advanced policing unit. Drones monitor the landscape and communicate with the androids and the electronic control centre.

The functionality of the artefact

Artefact Node 1: Android soldier

The androids (Figure 7) are fitted with advanced automated rifles, image recognition software, and sensors, all embedded to enhance their strategic and tactical functionality. The design is optimised to prevent and control criminal acts using extreme force.

[1] The students are referring to the 2022 Tembisa service delivery protests (Gumede, 2022)

© Copyright 2023 Design Education Forum of Southern Africa (www.defsa.org.za)

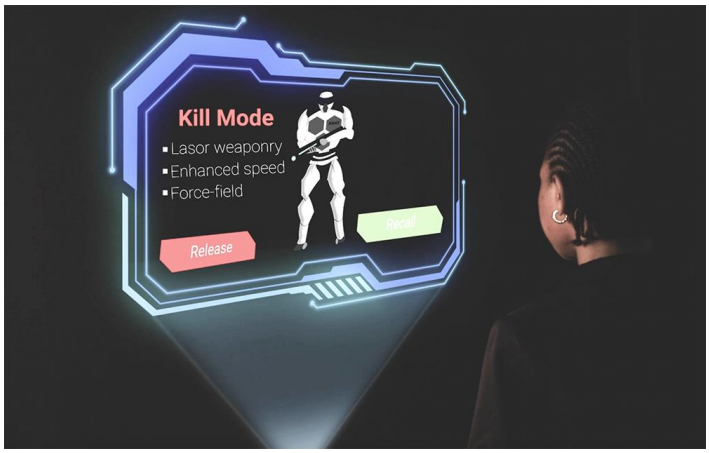

Figure 7: Android soldier being released

Artefact Node 2: Drone fleet

The drones (Figure 8) are conceptual eyes for the android soldiers. They use sophisticated video technology to capture and map cities and high-crime areas.

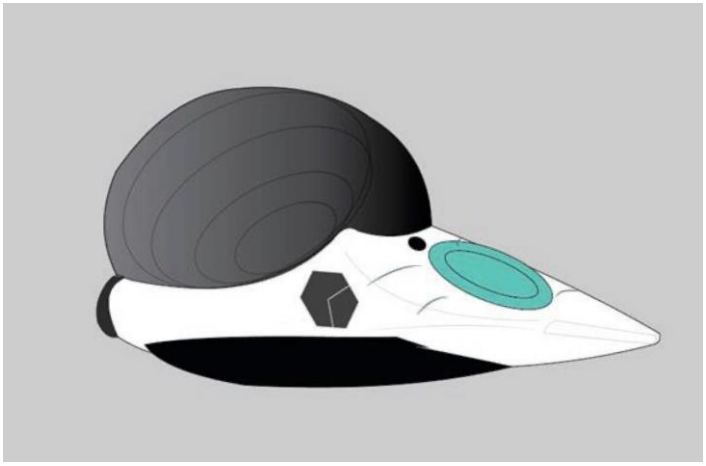

Figure 8: Design of the drones

Artefact Node 3: Control device and interface

An electronic device is concealed in a secure casing. It controls the system that is activated when the highest alert level is evoked. The device projects a digital interface (Figure 9) that humans can interact with to see the coordinates of problem areas, live footage of events, and the identity and personal information of the perpetrators. The interface can toggle between the various points of view from the built-in cameras embedded in the hardware of the drones and androids. Advanced calculations are processed to detect and identify the possible gathering of crowds and illegal activity.

© Copyright 2023 Design Education Forum of Southern Africa (www.defsa.org.za)

Figure 9: Projected interface

The final short film can be viewed on the following URL: <https://youtu.be/YhP538j72jE>

Project 3: Lifeline

This project addresses the public health crisis in South Africa. It looks at various technology interventions that were used during the COVID-19 pandemic, as well as cyber-physical systems used for healthcare and other applications. The project proposes a workable solution to the crisis facing public healthcare due to years of government corruption. The artefact is presented in an infomercial promoting a new healthcare microchip device and promising an end to the crisis.

The Scenario

It is 2072. Fifty years have elapsed since the first COVID-19 pandemic. South Africa's public healthcare system has all but collapsed due to corruption and resource management. The government relies on international aid agencies, such as the United Nations, for health resource funding. The current authoritarian government has decided to save the day by outsourcing healthcare to a private pharmaceutical company called Atlas. They have developed an implantable microchip that is being promoted as the solution to the crisis and promises to change the face of healthcare forever. The government has made using this system mandatory for the greater good of the nation. Citizens who refuse to use this health chip will be denied access to public spaces (Figure 10).

The Artefact

Lifeline is a cyber-physical system that monitors people's health. A physical pill-looking micro-chip device (Figure 10) is injected into a person's body.

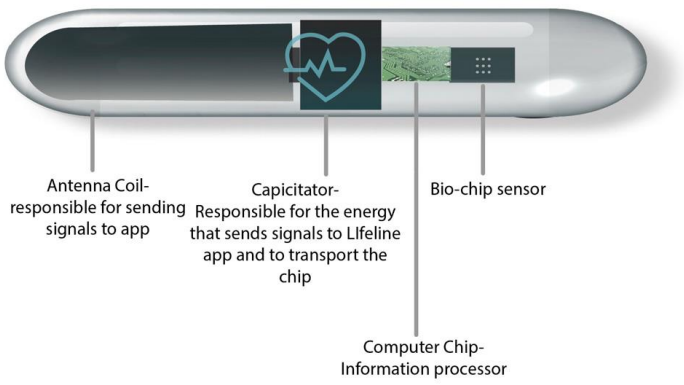

Figure 10: Lifeline chip

A digital barcode is then imprinted on the person's wrist (Figure 11), which contains information about when and where they were injected. There is a smartphone application that needs to be synced with the chip to provide feedback to the user regarding their health.

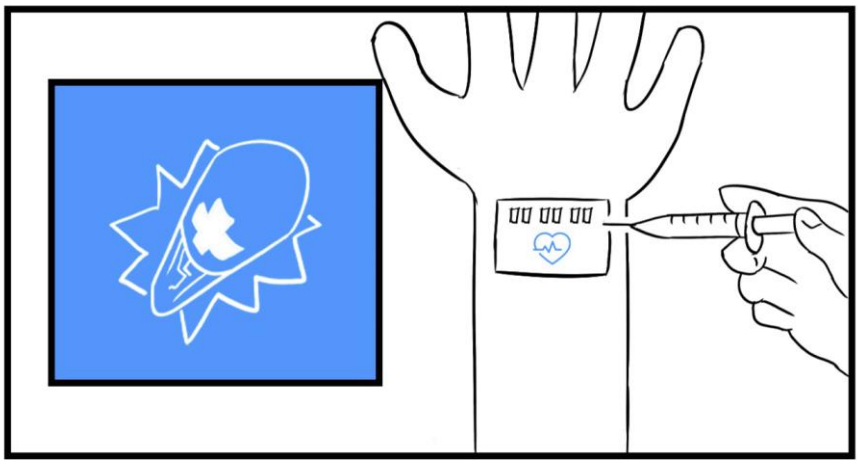

Figure 11: Lifeline barcoded access control RFID band

The Lifeline microchip contains a biosensor that collects health data from a person's blood. A microprocessor stores and interprets the incoming data. A capacitor stores the energy needed to transport the chip through the bloodstream. An antenna coil sends signals that can be read by the phone application and the RFID barcode. The application used advanced AI to identify new medical issues during the formative stages of the illness. It creates customised prevention, treatment, and recovery programmes based on each user's individual needs. In a situation where a person has contracted a contagious virus, RFID readers stationed in all commercial and residential buildings will be able to track the exposure and spread of the illness.

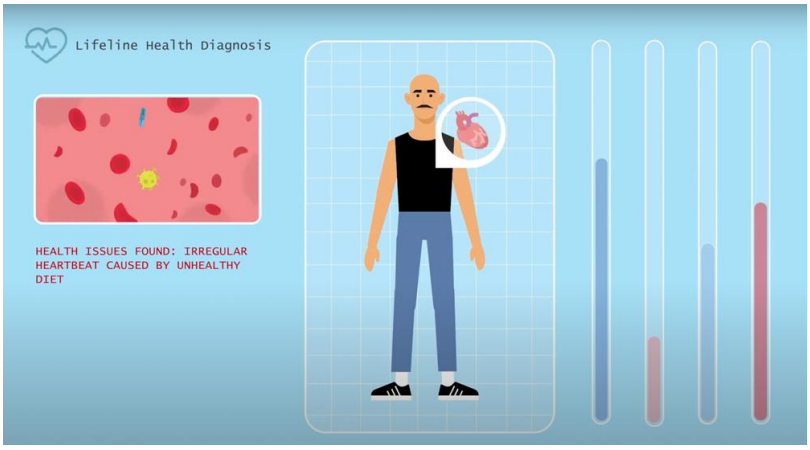

Figure 12: Lifeline system monitoring the body

The infomercial can be viewed on the following URL: <https://youtu.be/ryPYIn6TvF4>

Emerging themes

There were four key themes that stood out in the overall reflection of these three films. 1) The future scenarios depicted were either dystopian or utopian. 2) There were implicit assumptions that what happened in the past will happen in the future. 3) The future was viewed from a techno-centric perspective. 4) The narratives suggested that only people in power have agency in highly complex socio-technical contexts.

Anticipatory Systems Theory

Roberto Poli differentiates between an ability to anticipate for the sake of responding and planning and the systemic nature of anticipation present in anticipatory systems. As illustrated in Table 1, the future is anticipated in various ways. Anticipation can be explicit or tacit, open or closed, conscious or unconscious. We know that we can consciously plan and predict. Nevertheless, layers buried beneath our conscious awareness are involved in anticipation (Poli 2010). Adaptive complexity is built into all living organisms in the form of "anticipatory" systems. The organisation of the relational elements defines anticipatory systems. Because time always stands between cause and effect, anticipation is built into the very nature of adaptive systems. The present state of a system is composed of both the past and future state of the system, meaning that the system has an embedded knowledge of self and non-self (Rosen 2011). From within the sphere of human-computer interaction and cybernetics, anticipatory systems encompass a plurality of future possible states. Quantum entanglement is a metaphor used to describe multiple possible future states existing at the same time in the present. This model acknowledges the limitations of linear reasoning with cause-and-effect-based calculations (Nadin 2016). When it comes to human and social systems, future states are primarily determined by choices made by agents. Agents make decisions based on what they deem to be desirable or undesirable. Therefore, decisions about the future are determined by the frame of reference of the decision-maker (Fuller 2017). Assumptions and biases create narrowness in how the future is conceived. There needs to be more awareness of the assumptions and frames for imagining the future. There is a pre-scripted set of future imaginings influenced by history, social structures, and current reality, but also by chance, innovation, and human choice (Miller 2018a).

Table 2: Taxonomies of anticipation

Anticipation for planning	Anticipatory systems
Explicit (predictions and expectations)	Implicit (unknowable and emergent)
”Good” and “Bad” futures	Nuanced/contextual
Linear temporal causality	Dynamic and adaptable

Anticipatory Systems (AS) can be more closed or more open. If anticipation is used for forecasting and predicting, it functions more as a closed system constrained by probability and desirability. In contrast, living systems anticipate in a less conscious and constrained fashion. Social systems share some of these non-conscious anticipatory qualities that factor in evolving and emerging realities (Miller 2018b). When the future is used to surface ideas and novel discussions, the degree to which the AS is open affects the premisses relating to agency in practical choices. These assumptions influence the next-level assumptions that follow. Using anticipation to discover new ways of thinking about issues demands that AS be less deterministic in how change is conceived (Miller 2018b; Poli 2001). Exclusive use of critique in communicating and discussing desirable or undesirable futures closes room for agility and flexibility, which is necessary for transformation. Critique implores immediate action to avoid risk and uncertainty. This attitude leads to the framing of the future in terms of "good" or "bad", which in-

turn limits human agency and makes it difficult to see the layers of complexity and possibilities for transition. AS is a theoretical paradigm that helps use the future as a tool for sense making in the present. From this perspective, the future is not a "problem" to solve and conquer. Instead, it is a tool for exploration and experimentation. Acknowledging the dynamic nature of complexity creates an unpressurised space for confronting ambiguity and uncertainty without fear, which increases human agency (Miller 2018c). Within an African context, desirable futures are often conflated with visions of industrial catch-up and convergence and state-centric visions. Framing the future in this way resembles used and past futures imposed on Africa by colonial and neo-colonial influences. It is difficult to break away from visions of the future that do not involve conquering and ruling or Cold War planning paradigms (Karuri-Sebina & Miller 2018).

Thematic analysis

Reflecting on the topics discussed in student projects, the four consistent themes in the fictional future scenarios map neatly to the anticipation for planning and responding. As seen in Table 2, the ideas communicated by the fictional future narratives speak to planning-based anticipatory proficiencies, which are borne from expectations and value-based judgments and assume bounded causality.

Table 3: Common themes in the fictional future scenarios mapped to modes of anticipation

Themes	Anticipation for planning	Anticipatory systems
• Techno-centric • Only people in power have agency	Explicit (predictions and expectations)	~~Implicit (unknowable and emergent)~~
• Dystopian /Utopian Scenarios	”Good” and “Bad” futures	~~Nuanced/contextual~~
• What happened in the past will happen in the future	Linear temporal causality	~~Dynamic and adaptable~~

Table 3 links the thematic analysis of the films to Anticipatory Systems Theory. The presented projects' themes fall into the anticipation for planning category. This may be useful in some situations. However, it is not the best method to decolonise our imaginations.

Table 4: Thematic analysis

THEMES	The Bubble	Android Police	Lifeline
• Techno-centric • Only people in power have agency	Government has all the power and technology will be the main driver of the future – industry in the 4IR will look like the 3IR	“Terminator /Transformer” metaphor Abuse of power	Technological progress is a given. Only government can harness it
• Dystopian/Utopian Scenarios	There is only dystopia or utopia – the future must be good for some and bad for others	Dystopia with killing robots is the inevitable outcome of technology evolution	The ”greater good” can create a Utopia even at the expense of personal freedoms
• What happened in the past will happen in the future	A class system has always existed and will therefor always exits	People in power have all the power and will always have power	Autocracy will stop chaos

The observations from this analysis are by no means a criticism of student work or the value of SD. They do bring attention to aspects of instruction in SD that may need consideration when attempting to decolonise design education.

Project 1: The Bubble

This project is an excellent expression of a critical SD agenda. SD props are used to challenge ideals and beliefs and imagine alternative possibilities (Dunne & Raby 2013). The Bubble is quite effective as a trigger for critical reflection. It helps the viewer engage with ideas about class and wealth disparity and question prevalent ideas about how technology will prevent the consequences of industrialisation, such as the climate crisis. It creates a space to think about South Africa's response (or lack thereof) to climate change and the power structures that come into play. It points to classism, capitalism, exploitation, and technological determinism. The dystopian scenario depicted is a cautionary tale of the dangers of capitalism and technological progress. While this scenario talks to many current problems facing South Africa, it could be situated anywhere in the world. The film presents a colonised version of an industrialised future in which technology is the primary driver of change. It also focuses on the agency of the powerful. The socio-technical system depicted emulates normative ideas about progress being good for some and bad for others and assumes the class-based system embedded in colonialism will continue to exist forever in all contexts.

Project 2: Android police force

The technologically advanced policing system depicted in this project strongly resembles past versions of the future. Technological developments have created killing machines that the people in power are misusing. Set within the context of the social unrest in South Africa, the project is unsure of its stance on this type of technological innovation. On the one hand, it is presented as an answer to the real problems brought about by the riots and criminal activity that transpires regularly. On the other hand, it depicts a dystopic use of robotic policing technology. It indeed prompts a discussion about the importance of law and order and, at the same time, offers a critique of the policing and crowd control measures that are used within a South African context. It could also just as easily be applied to many other contexts worldwide, both in the Global North and South. The Terminator/Transformer metaphor is nested in a Global North worldview of the future, which assumes that technology will inevitably be misused and that power will be abused indefinitely.

Project 3: Lifeline

This project is slightly different to the first two projects. While not entirely utopian, it has utopian underpinnings that promote a technological determinist view of progress. The ideas presented in this project open some exciting avenues for discussion and reflection. It prompts questions about what is justifiable in the name of the "greater good" of society. It looks at modes of governance and the advantages and disadvantages of authoritarian rule. It evokes ambivalent feelings about technology, privacy, progress, and health policies. It indeed invites debate and critique. This project touches on issues of neo-colonialism, but simultaneously, it resembles the universal conversations arguing for and against non-democratic forms of governance. It assumes people in power are the best-suited candidates for change making and technology harnessing.

Conclusion

The theoretical concepts emerging from AS Theory give clues as to why the SD projects failed to provide unique Global South perspectives. The way the future is being used within SD creates a set of rules that make it difficult to re-imagine possible futures that account for different and diverse ways of imagining. Using the future for critical debate establishes a set of assumptions that make the anticipation more closed-looped. Critique implies providing, in most cases, a negative judgment (Cambridge Dictionary 2023). Using critique in SD promotes value-based judgement about what

© Copyright 2023 Design Education Forum of Southern Africa (www.defsa.org.za)

"good" and "bad" futures entail, which makes it easy to draw on used or past futures that tend to view possible futures through the lens of utopian or dystopian scenarios. Reflecting on this research has led to a set of considerations for new directions in teaching SD in South Africa. Table 4 proposes theoretical aspects of AS that could be introduced into the construction and framing of the SD project going forward.

Table 5: Findings and reflections

Anticipatory systems	New pathways for speculative design futures
Implicit (unknowable and emergent)	The future is uncertain – reacting with fear reduces individual agency
Nuanced/contextual	Employing "used futures" colonises the future
Dynamic and adaptable	Using the past as a template for the future is not useful as the future is emergent

Using a more open-looped approach to how the future is used creates a space to experiment with the future without casting judgment about what the future should look like. As stated before, the history of colonialism and neo-colonialism makes it easier to imagine the future by using our default vision of a preferable future, which usually promotes industrial catch-up and convergence or state-centric idealism.

The findings extracted from the thematic analysis of the three SD projects presented in this paper propose additional considerations that may be valuable for design educators in South Africa.

Before students conceive ideas about speculative futures, educators should facilitate conversations about how our visions of the future have been colonised. New methods for unearthing anticipatory assumptions should be explored. Uncertainty should be embraced as a space for experimentation and making sense of novelty. Complexity should be acknowledged and embraced for the emergence of agency and resilience. New ways of framing the future should be explored, and imagination should be given free rein to create visions of better futures.

References

Ambala, AT 2021, *Positioning Afro-diasporic speculative design episteme in South African higher education institutions.*

Cambridge Dictionary 2023, *Critique,* Cambridge University Press.

Dunne, A & Raby, F 2013, *Speculative everything: design, fiction, and social dreaming,* MIT Press.

Fry, T 2017, 'Design for/by "the Global South"', *Design Philosophy Papers,* vol. 15, no. 1, pp. 3-37.

Fuller, T 2017, 'Anxious relationships: the unmarked futures for post-normal scenarios in anticipatory systems', *Technological Forecasting and Social Change,* vol. 124, pp. 41-50.

Gumede, B 2022, 2 August, 'Tembisa protests, Krugersdorp anger raise fears of new wave of violence', *Mail and Guardian National,* <https://mg.co.za/news/2022-08-02-tembisa-protests-krugersdorp-anger-raise-fears/>

Karuri-Sebina, G & Miller, R 2018, *Case 7: all Africa futures forum: transforming Africa's futures,* Taylor & Francis, pp. 161.

Kwazema, M 2021, 'The problem of the present in West Africa: introducing a conceptual framework', *Futures,* vol. 132, pp. 102815, <https://doi.org/10.1016/j.futures.2021.102815>

Mareis, C, Greiner-Petter, M & Renner, M 2022, 'Critical by design? An introduction', *Critical by design? Genealogies, practices, positions*

© Copyright 2023 Design Education Forum of Southern Africa (www.defsa.org.za)

Martins, LPO 2014, *Privilege and oppression: towards a feminist speculative design.*

Miller, R 2018a, 'Introduction: futures literacy – transforming the future', in *Transforming the future*, Routledge, pp. 1-12.

Miller, R 2018b, 'Sensing and making-sense of futures literacy: towards a futures literacy framework (FLF)', in *Transforming the future*, Routledge, pp. 15-50.

Miller, R, 2018c, 'Sensing and making-sense of futures literacy: towards a futures literacy framework (FLF)', *Transforming the future*, Routledge, pp. 15-50.

Miller, R, Poli, R & Rossel, P 2013, 'The discipline of anticipation: exploring key issues', Fumee.org,

Nadin, M 2016, 'Anticipation and computation: is anticipatory computing possible?' *Anticipation Across Disciplines,* pp. 283-339.

Poli, R 2001, 'The basic problem of the theory of levels of reality', *Axiomathes,* vol. 12, no. 3-4, pp. 261-283.

Poli, R 2010, 'The many aspects of anticipation', *Foresight,* vol. 12, no. 3, pp. 7-17.

Prado, L & Oliveira, P 2014, 'Questioning the 'critical' in speculative & critical design', *Medium,* viewed 13 December.

Rosen, J 2022, 'Robert Rosen's anticipatory systems theory: the science of life and mind', *Mathematics,* vol. 10, no. 22, pp. 4172.

Rosen, R 2011, *Anticipatory systems*, New York, Springer, <https://doi.org/10.1007/978-1-4614-1269-4_6>

Sheraz, U 2021, 'Used futures as stumbling blocks to sustainable development', *Social Innovations Journal,* vol. 5.

Sheraz, U, Inayatullah, S & Shah, A 2013, 'E-health futures in Bangladesh', *Foresight,* vol. 15, no. 3, pp. 177-189.

Tharp, BM & Tharp, S 2018, *Discursive design: critical, speculative, and alternative things*. Cambridge, The MIT Press, <https://0-ebookcentral-proquest-com.ujlink.uj.ac.za/lib/ujlink-ebooks/detail.action?docID=5649566>