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Cite this article: Ramirez-Figueroa C, Nevin A, and Orme C (2025). The materialised temporality of dust: developing a biodesign methodology to spatialise time and temporalise space. *Research Directions: Biotechnology Design*. **3**, e4, 1–16. https://doi.org/10.1017/btd.2024.21

Received: 19 May 2024
Revised: 9 August 2024
Accepted: 18 September 2024

Keywords:
Dust; Temporality; Nonhumans; Archive; Site reading

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The materialised temporality of dust: developing a biodesign methodology to spatialise time and temporalise space

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Abstract

The paper uses the material and conceptual figure of dust and matter out of place to amplify more-than-human perspectives of time, to trace the changing orientations and ethos of a site. Dust contains a complex mixture of inorganic and organic material, made up of an exuberance of microbial life such as *Penicillium*, *Aspergillus* and *Cladosporium* and around 20 other fungal sources. We are interested in dust as a material and metaphorical device to situate and critique temporality and the way we narrate and investigate the past and future, from a non-human, microbial point of view. Dust implies residual matter, a contradiction to order often associated with dirt. It indicates something that needs to be removed, or rearranged, something that is "out of place," an element that does not fit. Dust also indicates time and space and signals movement and life: dust hosts a medley of non-human particles and microbial communities that engage in their own worldmaking practices. The paper brings together methods of "un-cleaning" with archival research and spatial methods of 3D scanning, modelling and mapping, as an opportunity to decentre human hubris and explore the ways in which non-humans have and continue to inhabit "our" spaces.

Introduction: Dust of future past

In this early project phase, we aim to create an ontological framework that explores temporality through dust's microbiological composition. This serves as a metaphor for the symbiotic relationships between organisms, knowledge production and shifting narratives at the Royal College of Art (hereafter RCA) Kensington Campus, viewed through a dust-bound microbial perspective.

In recent years, the RCA has rapidly evolved into a research-focused institution with an emphasis on leadership and innovation, turning its Kensington campus into a symbol of the college's "strategic transformation" (see Figure 1). Yet, dust holds a fundamental role within an art and design school. It's often associated with experimentation, the development of students' work and their professional identity. In the context of an art and design, school dust is perceived as contamination, a lingering remnant of the past. Dust is seen in high-tech centres and innovation hubs, as a matter out of place.

Dust embodies the essence of temporality, layering over objects as a record of time's passage. Throughout human evolution, our bodies have evolved alongside various microbial communities often present in the dust that surrounds us. Dust, as an object, contains remnants of living entities such as skin cells, pollens, microbes and fibres, serving as traces of transient human and non-human inhabitants (see Figure 2) (Wilson, 2014). It creates a random community of matter, forming an opportunistic archive of the evolving narratives in the RCA's transition into a hub of research and innovation.

We examine dust's bacterial ecosystems using Timothy Morton's concept of hyperobjects – complex systems beyond human comprehension (Morton, 2013). Hyperobjects shape our perceptions, politics, ethics and our grasp of time, mirroring the interconnectedness of microbes and humanity while emphasising knowledge's distributed and networked nature. Exploring the Kensington RCA campus through hyperobjects parallels the intricate, often hidden microbiological communities in dust, revealing their existence beyond human perception.

Dust serves as a metaphor for reflecting on human existence and temporality. Michael Marder suggests that dust, while fleeting, possesses a sense of "indestructible destructibility." It encapsulates time, operating as an "inexorable force of becoming" that exists between being and nothingness (Marder, 2016). In essence, dust encompasses various temporal activities

Figure 1. Promotional banner illustrating the institution's new ethos.

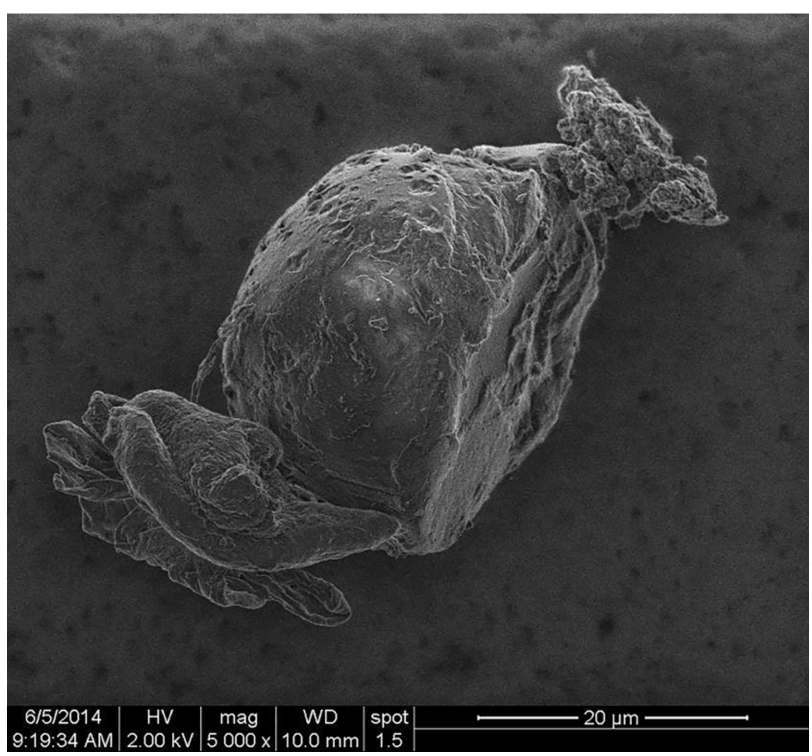

Figure 2. A SEM image of an organic particle primarily composed of carbon and oxygen at 5000 times magnification. Wilson, Helen. "Striking Images of Dust." The National Archives Blog, The National Archives, 18 Dec. 2014.

https://doi.org/10.1017/btd.2024.21 Published online by Cambridge University Press

that exist beyond our human framework. It inhabits overlooked spaces and envelops us, much like neutrinos, elusive subatomic particles likened to "ghosts slipping through the night" (NPR 2006).

The metaphor of dust "slipping through the night" represents its ability to transcend time boundaries and exist in non-linear temporal spaces. Michel Marder (2016) proposes viewing dust as "spatialized time and temporalized space." By spatialising dust's microbial activity and employing dust to manifest temporality in this project, we foster a revaluation of our long-term coexistence with dust and explore evolving narratives in the RCA's journey. Highlighting the microbial temporal dimension shifts the perspective from dust as a pollutant to recognising it as a microbial archive.

Anna Tsing (2015) notes that our encounters lead to contamination, reshaping identities and fostering new possibilities. As a hyperobject, dust operates rhizomatically, providing various avenues for contamination. This contamination can manifest undesirably, like hosting allergy-inducing dust mites, but it also extends to the contamination of ideas, ideologies, states and time itself. Throughout this project, we observed that dust accumulates everywhere, defying complete capture, and its particles slip away contaminating other spaces, carrying remnants of time within its intricate network.

Dust in archives is considered undesirable, as Neil Parkinson, Archives & Collections Manager at the RCA, pointed out when we discussed our project with him. He emphasised that while the college's archive contains ample information about the campus through oral histories, visual and textual documents and the archive website, the format of this information creates gaps, challenging to address through traditional historiographical methods.

In this project, we have been expanding our scope beyond humans to include a community of non-humans that shape and archive habitats and worlds. This shift has prompted us to explore novel methods for assembling a history of a location (the RCA), reshaping notions of time, inhabitation and space-making for non-human entities (Ait-Touati et al., 2022). The microbiological entities in dust craft their own enduring worlds, even as human activities evolve. This enables us to critique and analyse the university from a microbial perspective rather than economic, societal or political viewpoints. Developing an archive of dust, an empire of dirt (Reznor, 1994).

When examining archival photos of the Henry Moore Wing Gallery, the dust appears absent, despite our expectation that it would likely be present. These images of the Gallery (Figure 3), currently used by architectural students, portray a 1960s British

Figure 3. Darwin Building (Henry Moore Gallery). Courtesy Royal College of Art archive; photographer unknown.

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Figure 4. Construction of the Royal College of Art Workshop block (later known as Darwin Building). Courtesy Royal College of Art archive; photographer unknown.

modernist interior designed for exhibitions. In contrast, Figure 4, a black and white photograph of the under-construction RCA workshop block, reveals visible dust smears on the windows. These smudges were unintentionally captured by the photograph, preserving both a moment in time and evidence of dust-containing biomaterial.

We wondered: Did dust at the RCA accumulate in corners and under window frames, collecting years of biomaterials and bacteria from students and staff? How does evolving space usage driven by economic factors affect dust? Can dust act as a silent observer of changing space utilisation and be influenced by economic factors? In what ways could dust's ability to spatialise time be amplified, enabling us to trace the RCA's (strategic) evolution through its accumulation and an analysis of the biomaterial tangled in it?

Microbial histories

This project delves into our symbiotic existence with unseen organisms, amplifying our temporal interconnection and shedding light on living systems within, around and upon us. It prompts fresh perspectives on the relationship between human and non-human temporality. Throughout the project's development, we've recognised that dust serves as a unique type of archive of cultural, social, economic and political influences that have shaped the RCA. In line with Michael Marder's concept of amplifying a "community of what has been and what is yet to be," this project establishes a dust and microbiological-centred archive and inventory of traces and promises of RCA's transformation into a centre of innovation.

At the heart of this project lies the intricate connection between our microbial history and our social, cultural and environmental heritage. Over millennia, humans have co-evolved with diverse microbial communities, some of which reside in the dust around us. These microorganisms in dust play essential roles in processes like digestion, immunity and metabolism (Martin Blaser, 2014). Microbial communities within dust are dynamic, adapting to factors such as temperature, pH and nutrient availability. As a result, contemporary microbial communities differ from those of the past. Yet echoes of our microbial history continue, subtly influencing us through the captured temporality of dust. By collecting, and "un-cleaning," the dust from the RCA's Kensington campus (Figure 5), we can highlight the traces of previous visions and ideals of the role of art and design in society.

While exploring the Kensington campus, we couldn't help but notice the shifts and changes in the built environment that had taken place as studios and workshops changed use. For example, the Henry Moore wing was now the architecture studio, and the mosaic Phoenix by the Albert Hall end of the building (Figure 6) seemed to be struggling to rise against the reconfiguring that has happened, almost since the building was completed. In the building's patches, plastered over sections and remnants are left that hint at the various people and uses it has seen over nearly 60 years.

What we've revealed through the early stages of this project is that through the other worlds contained in specks of dust, there is an archive of biomaterial that highlights how the built environment is never static and that there is a symbiotic relationship between the memories of the building, found in traditional

Figure 5. Royal College of Art Kensington Campus in 1961. Courtesy Royal College of Art archive; photographer unknown.

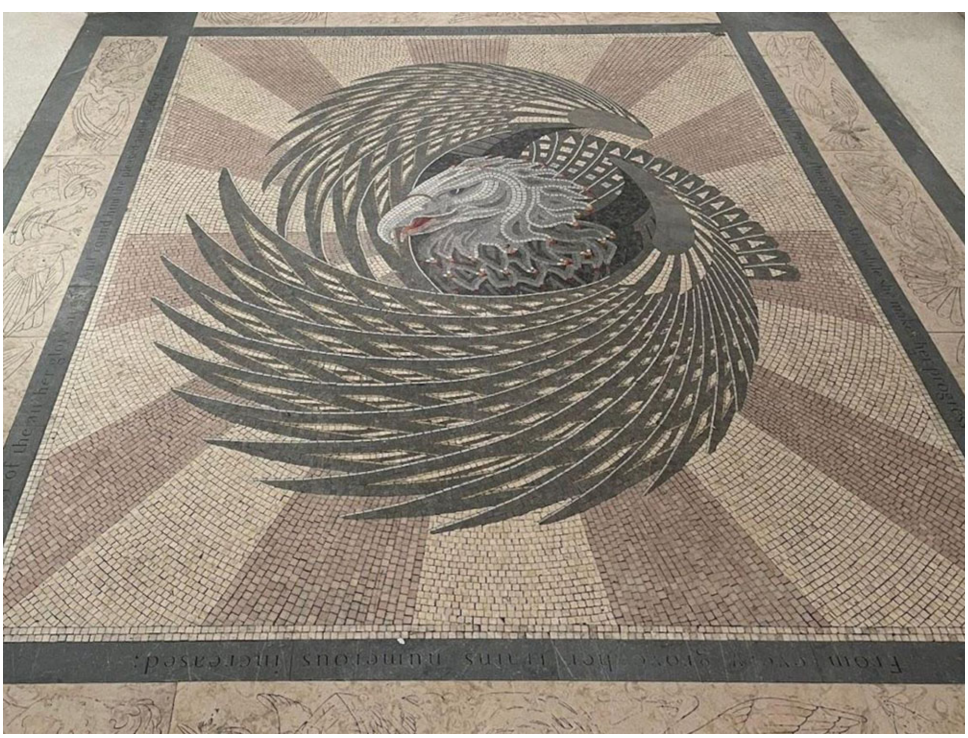

Figure 6. Darwin Building's main entrance shows the College "Phoenix" motif.

archives, and the memories captured by the dust that never quite leaves the building.

Methods: Methods of un-cleaning

With a view to amplifying the temporality of the biomaterial in dust, we apply microbiological techniques, such as detecting microorganisms and DNA sequencing, to reveal the microbial communities within the RCA (Diniz, 2023). We will combine these methods of "un-cleaning" with archival research, oral histories and spatial methods of 3D scanning, modelling and mapping, to create an alternative archive of the space that considers the experiences of humans and non-humans and that, instead of providing evidentiary "truth," enables to speculate on the temporalised space (Lammes et al., 2018).

Much like Antarctic scientists identifying ancient volcanic eruptions from ice core dust, we aim to detect seismic shifts in the educational landscape, exemplified by the RCA's strategic transformation (Roop, 2017). By adopting a method akin to drilling ice cores, we've established a protocol for collecting microbes entwined in dust that has tumbled into neglected corners. Through culturing and DNA sequencing, this might allow us to identify microbes and their distinct temporal and genetic signatures (Figure 7).

Undertaking a site reading helped us to identify areas of the college that had altered their purpose due to the impact of neoliberal models. For example, the senior common room now emphasises innovation. The Henry Moore Gallery has been transformed into an architecture studio, while spaces like the RCA Library have evolved into knowledge generation hubs, and design studios have been repurposed for making and experimentation.

In the project's early stages, we weren't sure where and how much dust we might find as we explored the campus, witnessing studios being made ready for exhibitions. Dust traces slowly emerged, uncovering the building's history as spaces were cleaned. While searching for dust, it became clear that the RCA sought to present its best for upcoming exhibitions, which raised concerns for us that accumulated dust might be removed. Nevertheless, dust endured despite cleaning endeavours, as the studio spaces transitioned from sites of exploration to showcases of innovation.

We focused on areas that had changed since the building's completion in 1962. The garden area has changed from a courtyard with a couple of trees as can be seen even in photographs of the construction. The change occurred when the RCA was given a variety of ferns after being used as the base for the 2012 Olympics by the United States Olympic Committee (see Figures 8 and 9).

Following our site reading plan, we laid out agar plates and collected dust samples (Figures 10 and 11) from the four areas we identified in our taxonomy of dust: the senior common room, the architecture studio (Henry Moore Gallery), library and courtyard (Figure 12).

We met with Neil Parkinson, Archives & Collections Manager. He articulated how as an archivist he disliked dust but grew intrigued by our idea of dust as a parallel archive. This led us to explore online archives, where we found most images for this article.

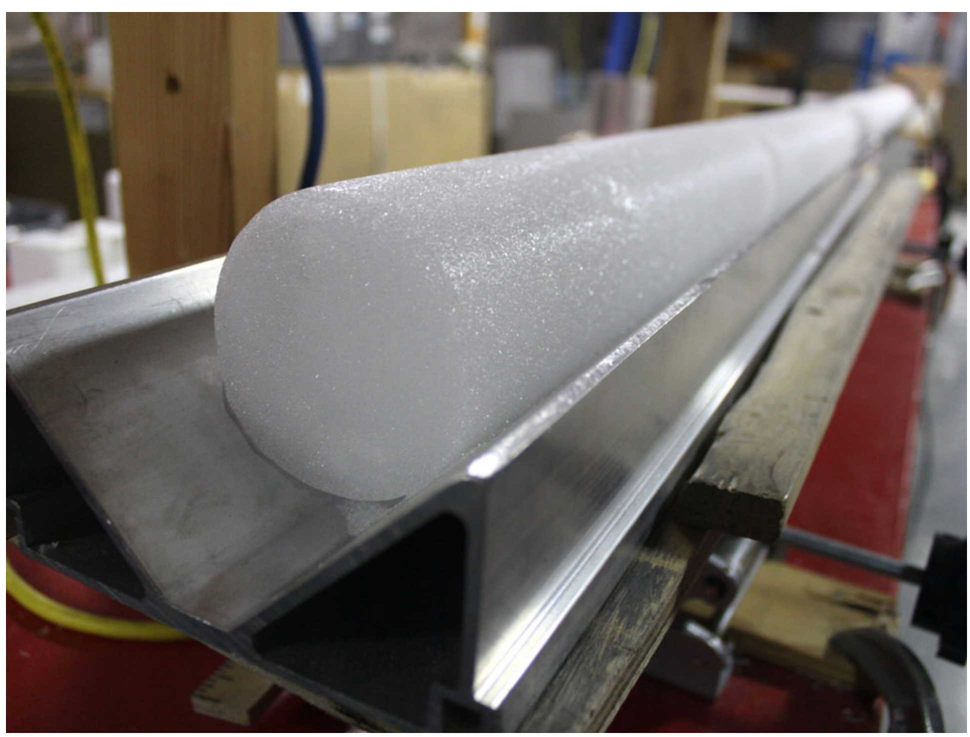

Figure 7. The image shows a portion of the ice core. Antarctica WAIS Divide Field Camp. Credit: Eli Duke.

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Figure 8. Royal Albert Hall from RCA Kensington campus, 1964. Courtesy Royal College of Art archive; photographer unknown.

Figure 9. Courtyard and common room block, Darwin Building, Darwin Building, 1964. Courtesy Royal College of Art archive; photographer unknown.

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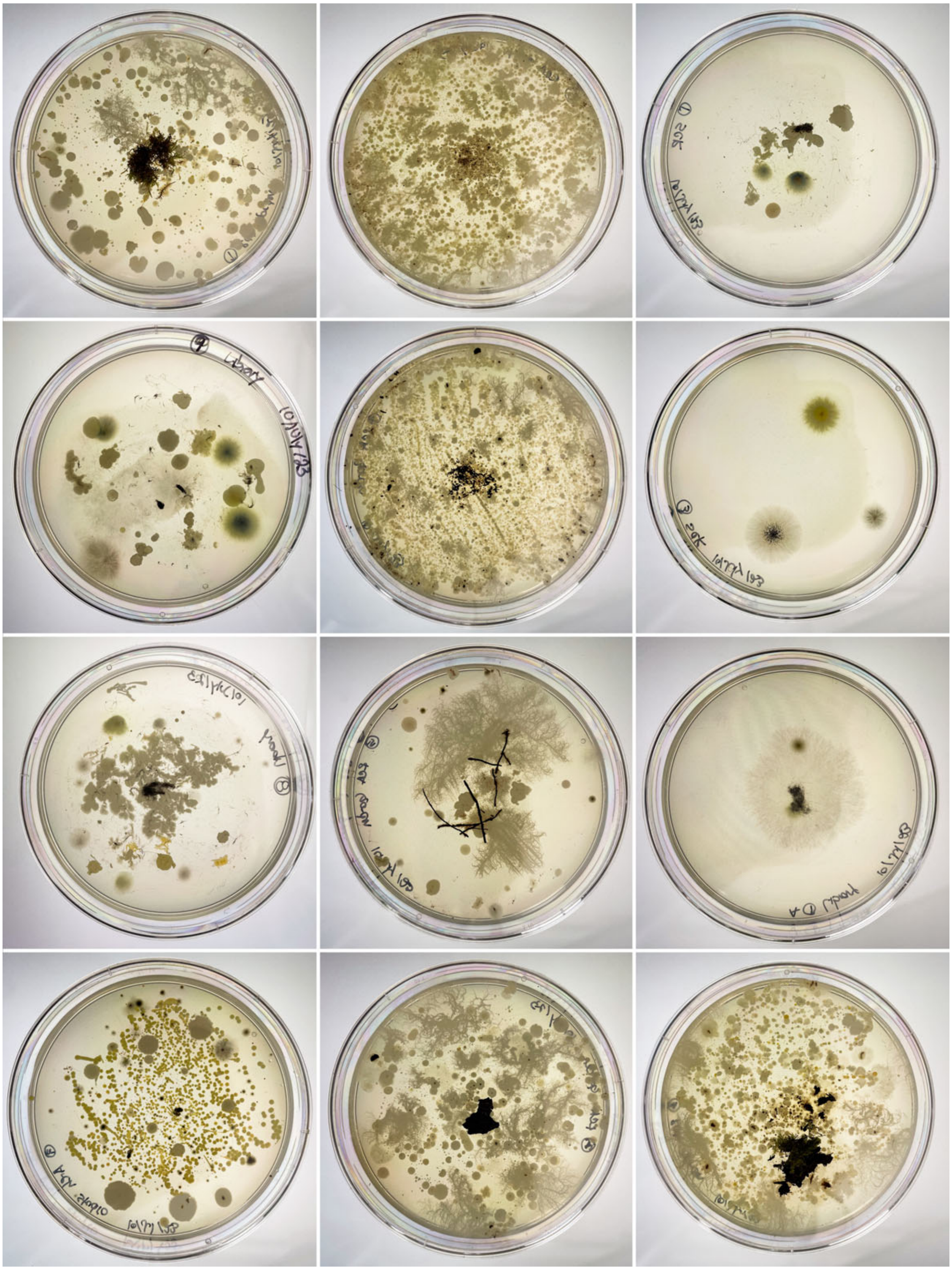

Figure 10. The photo shows bacterial growth on agar plates that were placed in the five chosen locations at the Kensington campus.

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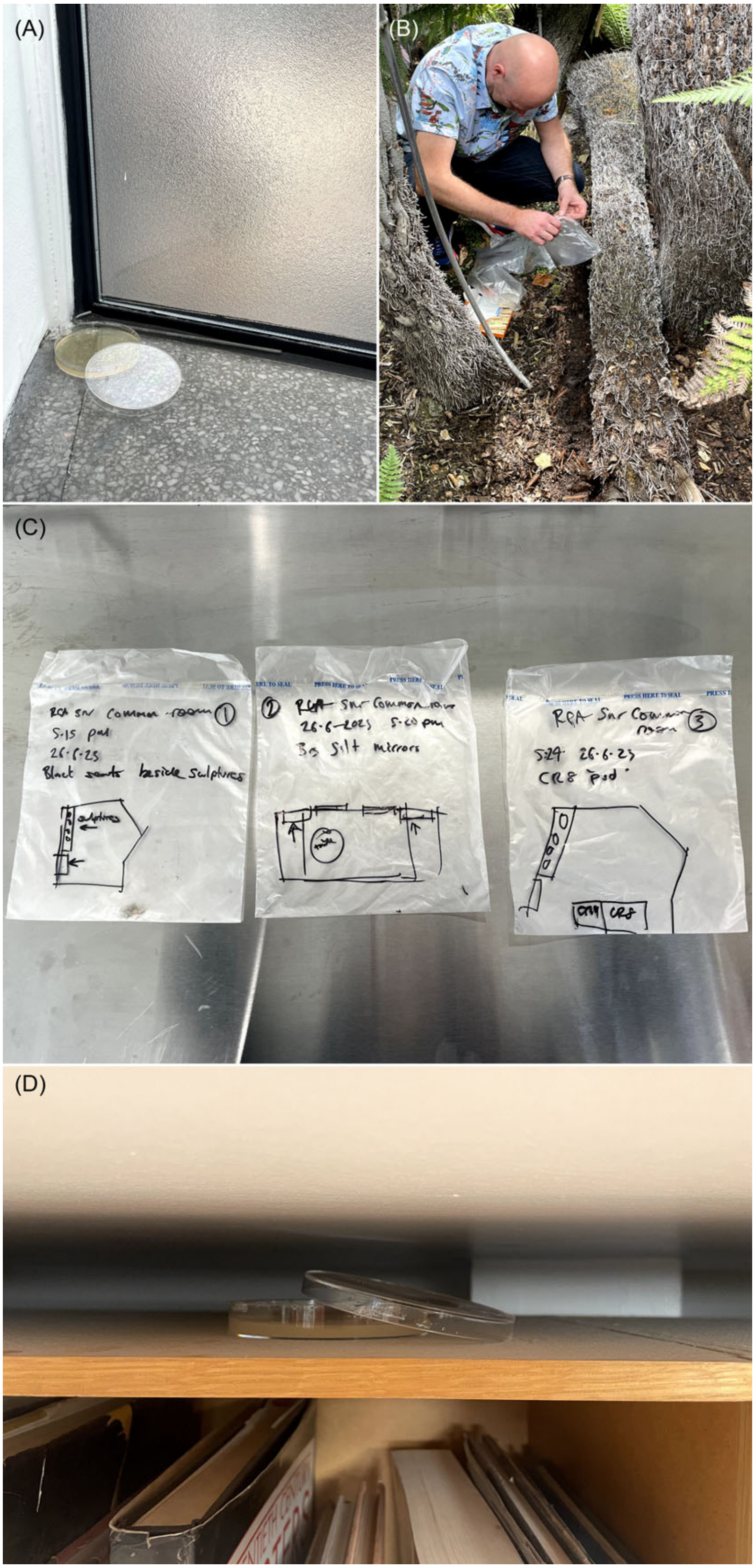

Figure 11. Clockwise. (A) Agar plate located in a corner of the senior common room (SCR). B) Dust collection of Courtyard. (C) Plastic bags containing dust samples from the SCR. (D) Agar plate positioned at the top of a bookshelf in the library.

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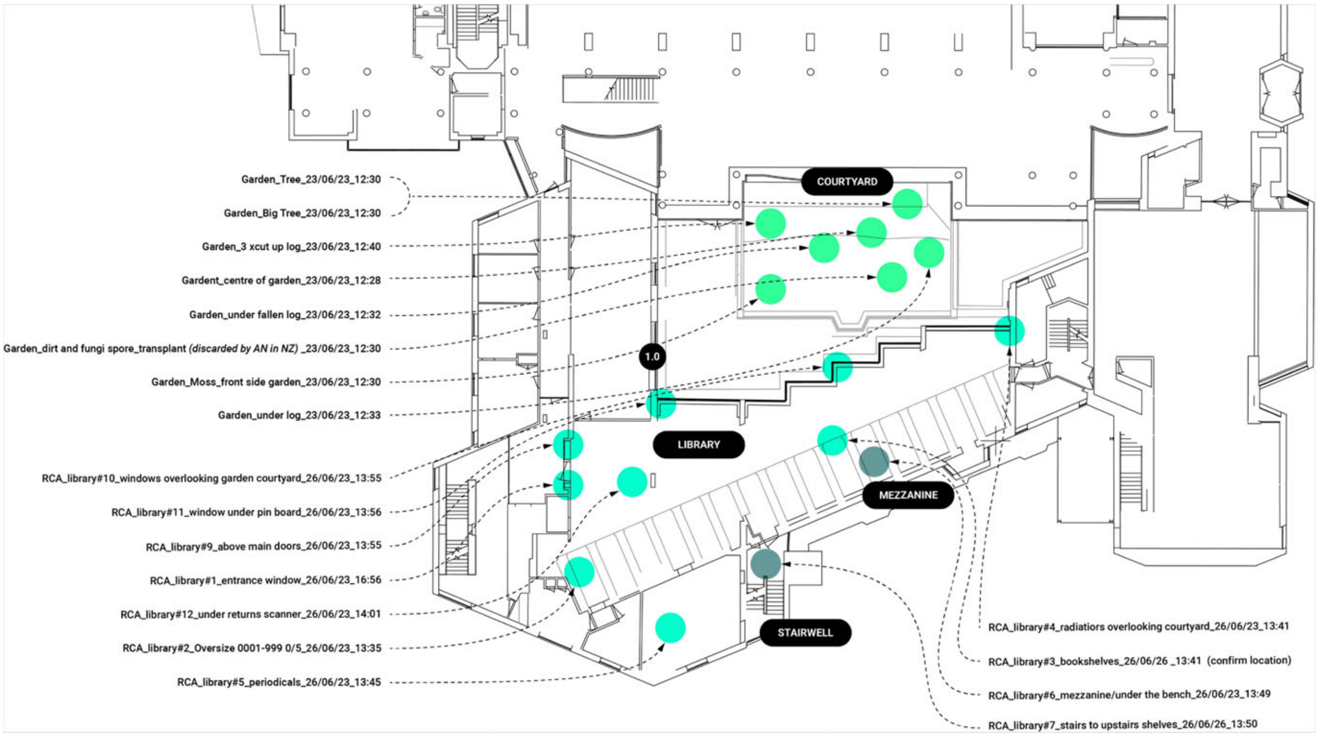

Figure 12. Floor plan indicating the locations of dust collection and agar plate placements.

Analysing the microbial data

We distributed fifteen agar plates across various sites at the Kensington campus, with a focus on the senior common room and library. These plates were incubated for seven days and, after a slow start, exhibited respectable growth (Figure 10). The next stage involves identifying the different bacterial colonies growing on the plates. To achieve this, we will use the Bento Lab, a portable all-in-one DNA workstation that combines several essential tools for DNA analysis using polymerase chain reaction (PCR) assays. The results will then be sent for sequencing by Genewiz, who utilise 16S rRNA gene sequencing and internal transcribed spacer sequencing to identify bacterial and fungal strains, respectively.

PCR is one of the most important laboratory methods in molecular biology. It acts as a genetic magnifying glass and photocopier combined, identifying specific genes present in organisms. Using "gene banks," it can determine the origin of the DNA.

We consulted molecular biologist Brian Douglas, who indicated that through basic culturing, successful PCR and basic Sanger sequencing from Genewiz, we will be able to gain a deeper understanding of the microbial taxa present in the dust at the RCA. Although we suspect that most of our cultures will consist of common environmental species and genera such as *Penicillium*, *Aspergillus* or *Cladosporium*, the main focus of this exercise is to gain a better understanding of the microbial landscape over space and time.

Results: Digital twinning

We used a combination of photogrammetry and LiDAR (Light Detection and Ranging) laser scanning processes to capture Digital Twin records of the sites themselves, as well as tools to help sketch and envisage with, leveraging data that can be post-processed into renders, video and interactive applications. With these methods, we can explore the dust's microbiological sites, at different scales and altitudes, or even start to examine representations of microbial senses.

In one instance, we used an Artec Leo (Figure 13), a handheld scanner often used in automotive and engineering applications for scanning components and complex objects, to capture a record of the original architectural model of the RCA renovation (Figure 14). The resulting 3D model was used to generate video footage where we can stand on the steps of the building, despite its reduced original scale.

Across the Kensington campus, we used three main fidelities of scans for capturing our sites: mobile photogrammetry using Polycam for building quick, coarse resolution models of field locations; a Leica BLK (Figure 15) with ~60 m range; and a Faro Focus with ~130 m range (Figure 16) for more detailed data capture. For the exterior courtyard at the RCA, we set up 15 locations where we could collect our laser scans in order to create a site survey (Figure 17) and for the interior library, 12 individual locations. These individual scans were later combined and registered, in order to generate 3D geometry of both locations.

Once we develop a mesh for each site, we then align images to it (Figure 18). These textured models give us a starting point for early experiments with different perspectives (Figure 19), using movement and non-human fields of view.

The process for texturing our 3D models also results in the diffuse maps required for its materials. As a by-product of the process, we now have "digital exhaust" diffuse maps generated when texturing meshes, from individual site photos combined with laser

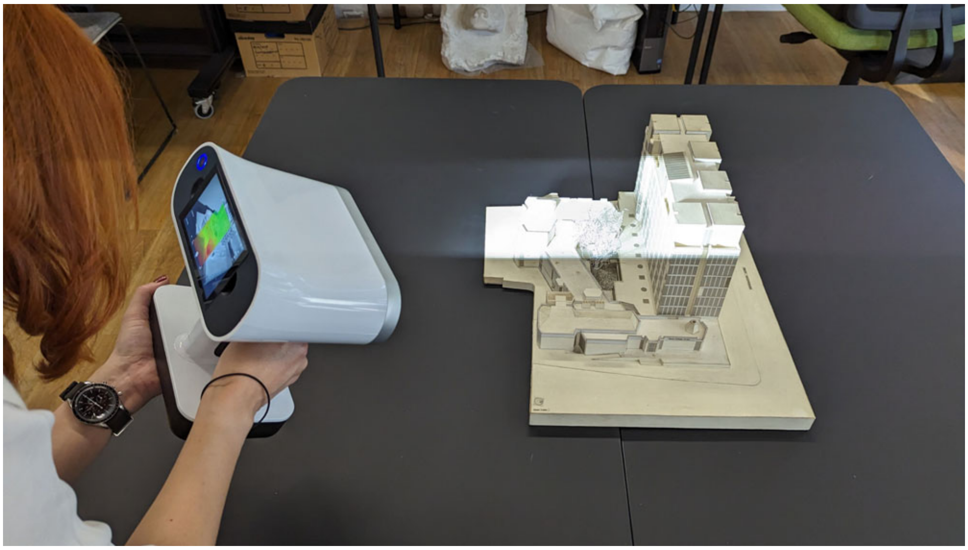

Figure 13. Image showing Carolina using an Artec Leo to capture the original cardboard model of the Kensington Campus.

Figure 14. Resulting 3D model of the Kensington Campus from scanning.

scan. This offers another way of interrogating our scenes: a flattened tapestry-like maps of all its corners and nooks (Figure 20).

Our previous video examples showed linear, pre-rendered video. Novel methods with Gaussian Splats (a method derived itself from neural radiance field, or NeRF techniques) means that we can take 2D imagery and build complex 3D models that allow us to explore with scale, viewpoints and movement in real time, without requiring the steps of generating traditional 3D geometry (Bernhard et al., 2018). This method affords us ways to quickly interrogate a scene, without the expense of pre-rendering sequences (Figure 21).

Following the steps of processing, combining laser scans and photography, optimised versions of our models' geometry and textures can be viewed within a Unity application running on an untethered Virtual Reality device such as a Meta Quest VR headset. Within our Unity scene, we can position cameras, affect shaders, change scale and trigger spatial audio. From within the application, a viewer can then physically move and look around the model, as well as teleporting around several predefined starting points using the headset's controllers. Within this immersive VR experience, our aim is to enable audiences to experience a microbial viewpoint of spaces changing over time in response to changing socio-

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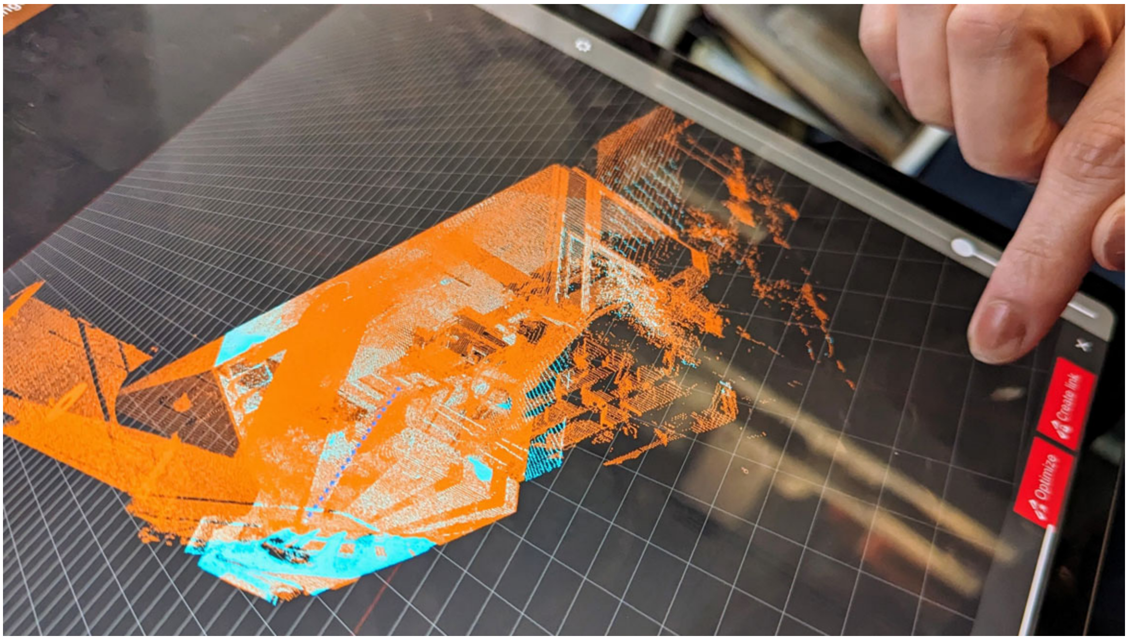

Figure 15. Initial interior test taken with the Leica BLK.

Figure 16. On site, setting up a Faro Focus laser scanner.

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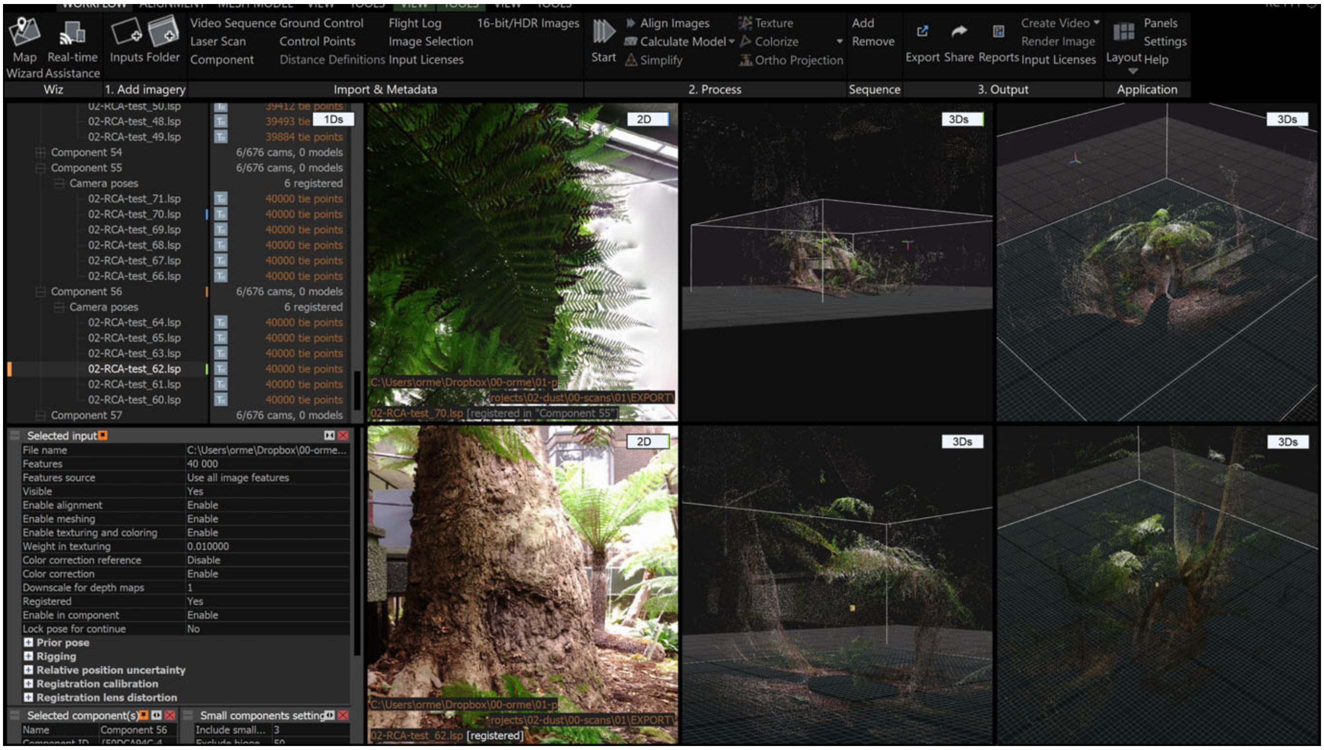

Figure 17. Image showing a portion of the workflow for photogrammetry and LiDAR scanning of the courtyard.

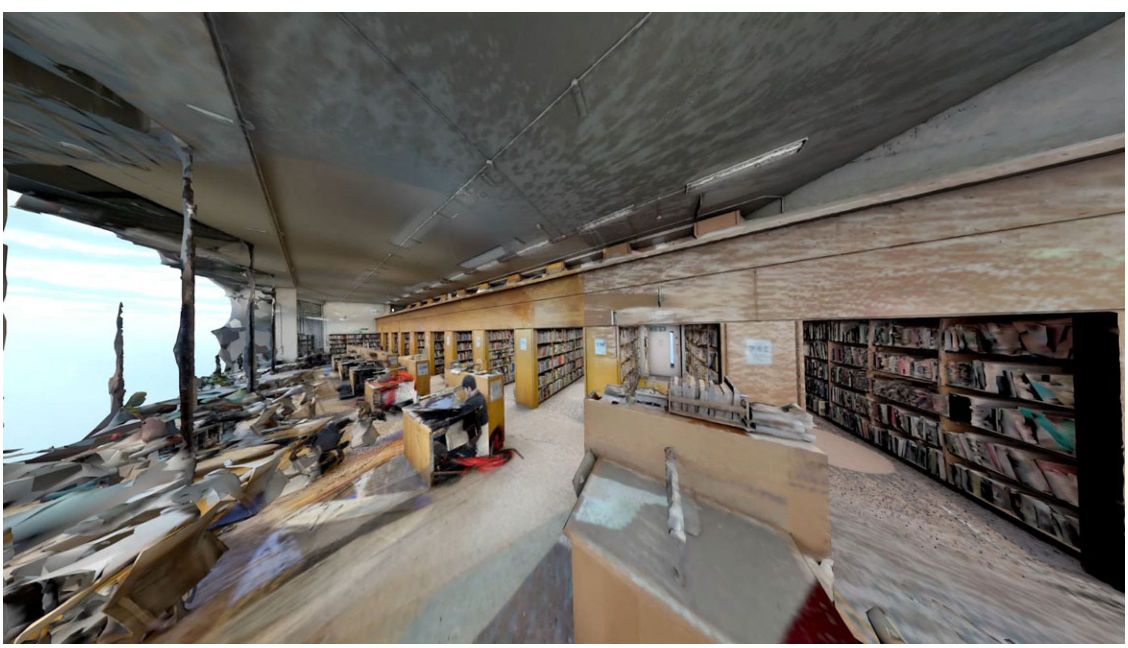

Figure 18. Images aligned with mesh, still from animated sequence.

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Figure 19. An early experiment with alternate perspectives, still from animated sequence.

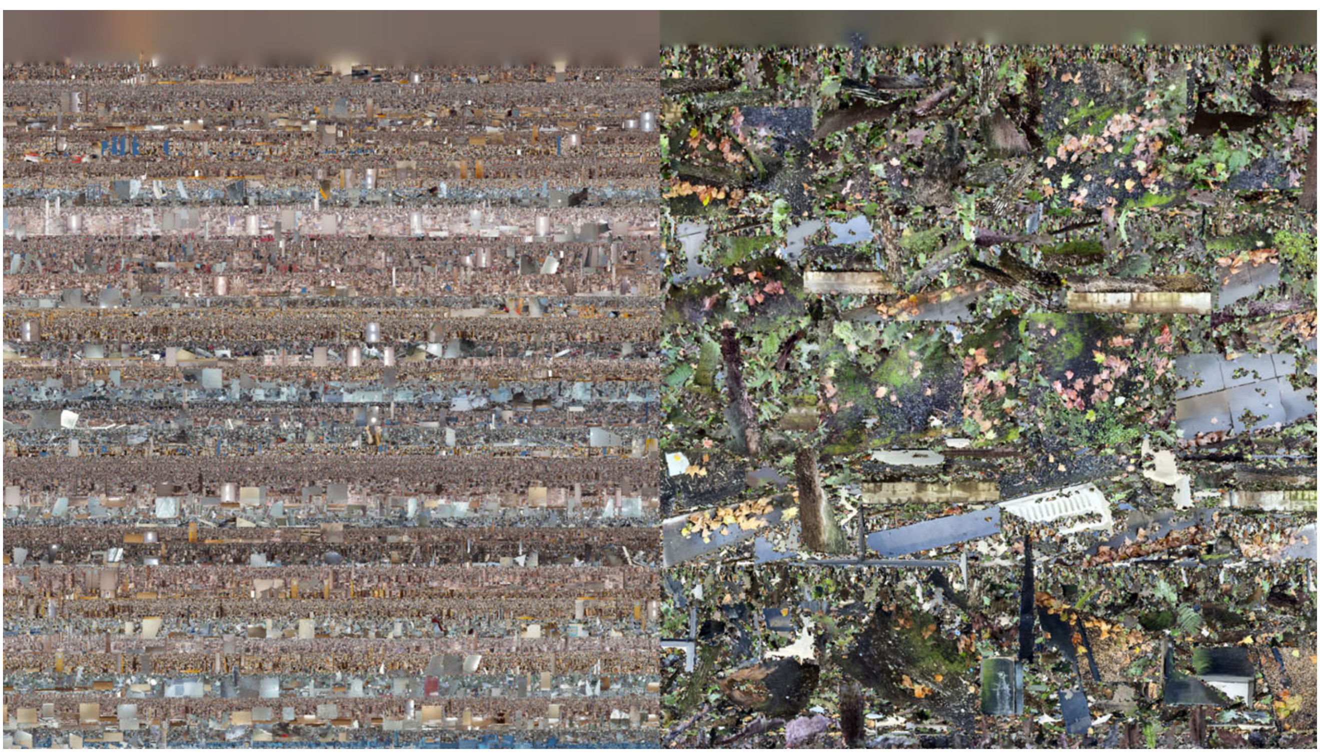

Figure 20. “Digital exhaust” – diffuse maps generated when texturing meshes, from individual site photos combined with a 3D scan.

economic imperatives. This interdisciplinary experimental method creates a novel archive highlighting microbial rather than human experiences of space and time, ultimately taking us into new experiential environments and away from linear videos running on a screen (Figure 22).

The data generated from our laser scans is substantial, necessitating further optimisation of our models within the Unity prototypes. Nonetheless, this preliminary test is already showing promise, as it allows viewers to re-experience the captured sites from a non-human perspective. By capturing and digitising diverse spaces

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Figure 21. Portion of library interior rendered with Gaussian splats.

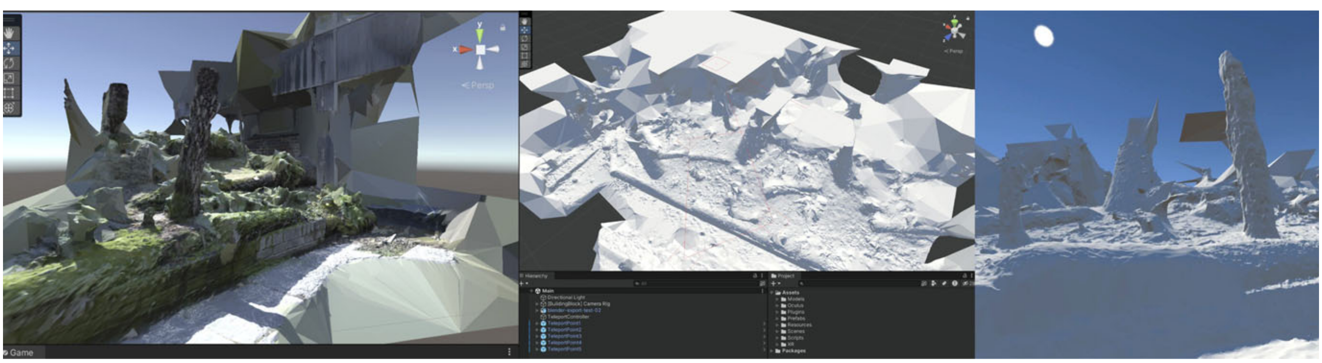

Figure 22. Unity scenes from test VR prototypes.

from the RCA library in Kensington, as well as microscopic realms like samples of microbial cultures the resulting virtual environment not only allows the audience to navigate these spaces from various perspectives but also enables us as creators to position virtual cameras strategically, manipulate scale dynamically and trigger spatial audio cues, creating a deeply immersive and interactive experience that bridges the macro and micro worlds.

Conclusions

This evolving methodology highlights our symbiotic existence with unseen organisms, amplifying our temporal interconnection and shedding light on living systems within, around and upon us and the built environment. This project highlights how there is an opportunity to develop a deeper comprehension of the intricate connections and collaborative dynamics between laboratory protocols and scientific methodologies, alongside the tools and strategies employed in design and production. Early research results reveal that, within the evolving RCA narratives, merging scientific methods and scanning technology with temporal concepts offers a fresh perspective on human–non-human relationships. This approach helps us grasp how dust, with its microbial content, can spatialise time and temporalise space.

Inspired by Bennett's "Vibrant Matter" (2010), which emphasises the interconnectedness of all entities, we propose that non-human elements, like biomaterial within the dust, actively shape our world. Our project aims to highlight the ubiquity of dust, challenging the conventional notion of it being destructive to archival preservation. Instead, we propose a complementary archive by extracting biomaterial traces from dust, enabling the temporalisation of spaces and built environments within an institution that has been undergoing a significant shift in emphasis since its establishment nearly 60 years ago.

The early stages of this project suggest that dust's microbial activity acts as a narrative archive, allowing us to trace the RCA's strategic transformation. Derrida's "Archive Fever" (1994)

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challenges traditional archival concepts, revealing their complexities, selectivity and biases. In our work, we've identified dust as a bio-archive, echoing Derrida's concept, enabling us to transcend human perspectives and rethink historiographic approaches to the archive, emphasising the potential of non-human temporalities in space. This project recalibrates or rather re-biocalibrates our perspective, enabling the development of a methodology that acknowledges non-human temporalities in space and rethinks historiography by amplifying dust as a witness and archive of strategic transformations.

Data availability statement. Not applicable.

Acknowledgements. Luke Holland, independent interaction prototyper, for the support on Unity concepting.

Financial support. Funding for Antony Nevin from College of Creative Arts, Massey University, New Zealand, Massey University Research Fund.

Competing interests. There is no conflict of interest from the authors.

Ethics statement. Ethical approval and consent are not relevant to this article type.

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