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A reflective lab journal for biodesign: Navigating more-than-human sensibilities and disciplinary tensions

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A reflective lab journal for biodesign: Navigating more-than-human sensibilities and disciplinary tensions

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This paper introduces reflective journaling as a tool for advancing biodesign practices, merging documentation methods from biology and design while integrating more-than-human sensibilities into laboratory practices. It highlights the need for tools that can flexibly support record-keeping across biology and design, balancing precision and accountability with iteration, creativity, and collaboration. Furthermore, it critically addresses calls to support care ethics and nurturing multispecies interactions within biodesign. Through an explorative review of diverse documentation formats, including laboratory notebooks and annotated portfolios, and informed by our own biodesign experiences, we introduce the Reflective Biodesign Lab Journal as a potential approach to address these needs. This innovative format is designed to support rigorous experimentation, creative design processes, and interdisciplinary reflections. This proposal lays the groundwork for addressing the unique nature of biodesign experiments, unlocking new possibilities that transcend the limitations of traditional disciplinary approaches.

Keywords: *biodesign; more-than-human; documentation; microorganisms*

1 Introduction

The tools designers and researchers use to document their work are not merely passive artefacts but actively shape practices. As Donna J. Haraway wisely stated, “It matters what matters we use to think other matters with” (2016, p. 12). For instance, documentation tools are essential in design processes, shaping how knowledge is understood, communicated, and developed (Gaver et al., 2022). Similarly, in biodesign (Myers, 2012), these tools influence how designers engage with, represent, and reflect on the process of working with living microorganisms.

Focusing on documentation tools in biodesign is particularly interesting, as it reveals some of the distinct challenges that designers and researchers face in this field. Designing with microorganisms presents unique challenges, mainly due to the tensions arising from the differing practices and methodologies inherent to biology and design (Armstrong, 2022; Camere & Karana, 2018; Kim et al., 2023; Merritt et al., 2020; Pataranutaporn et al., 2018). These challenges become notably evident in



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the documentation of biodesign processes within biolab settings, where tools and methods from both disciplines are often integrated to address their specific demands.

Alongside the need to address these challenges arising from the interdisciplinary nature of biodesign experiments, there is a pressing need to integrate more-than-human (MTH) sensibilities into biodesign (Karana et al., 2023). This has been articulated as the need to foster “situations that encourage creative assemblages, where humans actively participate and coevolve with non-humans within a dynamic ecology of interconnected living and non-living entities” (Karana et al., 2023, p. 4).

Design scholars have explored these sensibilities through various approaches, such as examining temporal alignment for microbial care (Zhou et al., 2023), engaging directly with microorganisms (Bell et al., 2024; Ofer et al., 2021; Risseuw et al., 2024), and attuning to microbial processes (Ofer & Alistar, 2023, 2024). Kim et al. (2024) delved into the notion of *becoming with*, offering pathways to foster sensibilities attuned to microbial times, scales, and metabolic activities. Yet, relating to these sensibilities within biolab settings remains a significant challenge. As some scholars have noted, this difficulty stems not only from the technical complexities of working with living materials but also from the limitations of existing design frameworks, many of which are rooted in Western and colonial anthropocentric traditions that can hinder cohabitation within more-than-human ecosystems (Nicenboim et al., 2025).

In response to these two challenges, we propose the Reflective Biodesign Lab Journal as a starting point for exploring alternative documentation formats. We ask: How can biodesign documentation navigate its disciplinary tensions while integrating MTH sensibilities into its practices? It aims to accommodate a spectrum of biodesign practices, from careful validation to creative exploration, fostering connections across biological and design contexts. Focusing on documentation allows us to examine and shape how biodesign should navigate its disciplinary tensions, as record-keeping both reflects a field’s priorities and practices and can be adapted to bridge the different expectations inherited from biology and design. In biodesign, no established format exists; microbial or lab-based projects typically rely on laboratory notebooks inherited from biology, which emphasise scientific rigour, highlighting the need to explore a broader range of documentation methods.

First, we explore a range of documentation formats from both biology and design research. We highlight two to four representative formats from each field, chosen not for exhaustive coverage but for the insights they offer into biodesign documentation, framed by our positionality in microorganism-focused, lab-based biodesign within an academic institution. Our observations draw on examples from biology, design, and biodesign practitioners, complemented by relevant literature. By bringing these formats into dialogue, we reflect on the values they surface within each domain. Building from these explorations, we sketch out opportunities for a journaling tool attuned to biodesigners and suggest a possible documentation format to support reflective and interdisciplinary practice. Finally, we discuss the potential of this tool to open further questions and experiments across diverse biodesign settings.

2 Unpacking biodesign challenges

2.1 Interdisciplinary tensions in biodesign

Collaborating across two distinct disciplines is inherently challenging, as it involves navigating various hindrances, such as differences in terminology, methodological approaches, and often divergent goals and objectives. In one of William Myers' interviews, bioart researcher Oron Catts explains,

“The main issue with almost all types of cross-disciplinary collaboration is that of language. The same words and expressions can mean totally different things for different disciplines, let alone the specialized jargon that each discipline maintains. There are also the differing methodologies and the meanings of experimentation in science and art/design.” (Myers, 2012, p. 272)

To address some of these issues, biodesigners emphasise the importance of maintaining an open-minded approach to experimentation and design research. This perspective allows them to recognise opportunities even in unsuccessful experiments, valuing outcomes that deviate from initial research questions (Camere & Karana, 2018).

Biodesigners also share concerns about dilemmas and tensions regarding strict protocols that are commonly associated with laboratory experiments, which often create challenges in balancing precision with creative exploration (Bell et al., 2023; Groutars & Risseuw et al., 2022; Zhou et al., 2024), critical imagination and care ethics (Armstrong, 2022; Ginsberg & Chieza, 2018). Effective strategies for navigating these tensions include alternating between controlled laboratory environments and more flexible design studios, where casual engagement with microorganisms can foster creative interpretations (Zhou et al., 2023). However, such flexibility must be accompanied by a rigorous understanding of biological safety and ecological complexities, emphasising the need for interdisciplinary collaboration to mitigate potential risks and unintended consequences when working with living systems (Groutars et al., 2024).

In responding to these challenges, biodesigners contribute innovative practices that complement and sometimes extend upon conventional scientific approaches. For instance, as shown in Figure 1, Camere and Karana (2018) interviewed eight design professionals who specialise in growing materials for design purposes.

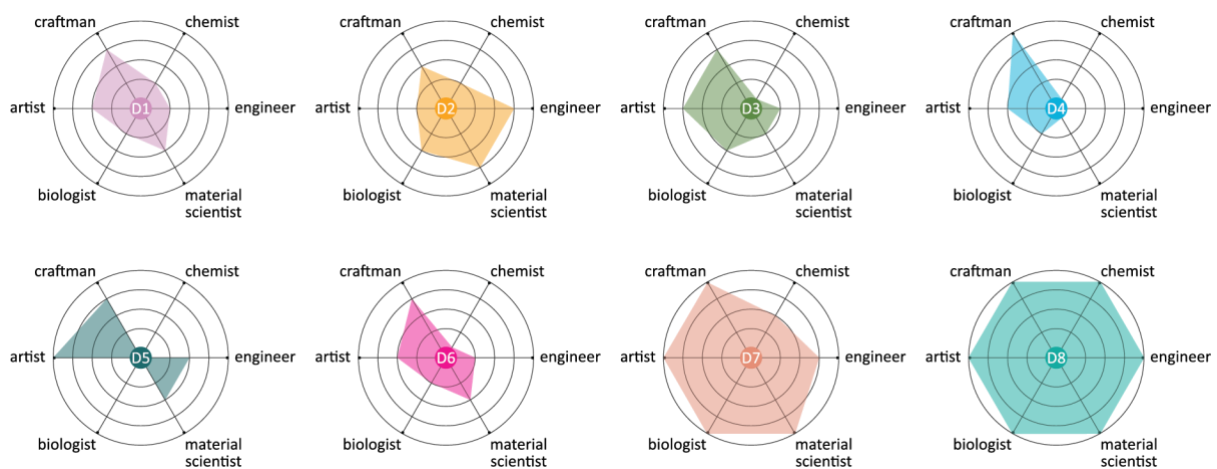


Figure 1. Designers' answers in diagrammatic form, representing how each interviewee feels towards the listed disciplines. Adapted from Camere & Karana (2018).

One such response, offered by a biodesigner who has worked with fungal and algae materials for ten years and identifies as a generalist with a strong disciplinary connection in materials science and engineering, as well as in craft and biology, illustrates some of the strategies employed to navigate the tensions inherent in this emerging field:

“(…) okay, you are in the lab, that’s how you grow things: don’t grow it that way. Find your own way to grow things. Which is something very difficult for a scientist to start doing. That’s what they are taught, and that’s what they do (…). I was growing pure cultures for a project which was about plastic degradation. And then it happened that because I did an experiment in the wrong way, there was a certain growth happening (…). And then suddenly there was a pure material of mycelium. Which was like, ‘wow, this is amazing’. And I remember the professor having the same surprise (…). But why does it happen? because you’re just not respecting the rules. So, you’re messing it up. And that’s where … from that coincidence, potential innovation can arise. (D2)” (Camere & Karana, 2018, p. 578)

Although biodesign draws on fields beyond biology and design and involves numerous unresolved tensions, we focus on these two disciplines as fundamental pillars of contemporary biodesign practices. Documentation tools in biology often extend to related sciences, while in design they can encompass the broader creative industries, with the prominent tension between scientific rigour and creative freedom frequently emerging at their intersecting field.

2.2 More-than-human sensibilities in biodesign

Given the current social and environmental challenges, the field of design is questioning the anthropocentrism of traditional design approaches (Nicenboim et al., 2023). This shift seeks to expand the scope of design with diverse human and other-than-human perspectives (DiSalvo & Lukens, 2011; Giaccardi & Redstrom, 2020; Wakkary, 2021). This entails “designing for the interdependent relationships between humans, technologies, and other organisms (such as animals, plants and microbes)” (Poikolainen Rosén et al., 2024, p. xix).

Grounded in posthuman theory (Braidotti & Hlavajova, 2018) and increasingly through practice (Nicenboim et al., 2024; Poikolainen Rosén et al., 2024), designers and researchers emphasised the need to support care ethics, relational thinking, and multispecies interactions (Groutars et al., 2024). In line with these developments and inspired by feminist scholars such as Donna J. Haraway (2007), María Puig de la Bellacasa (2017), and Anna L. Tsing (2015), biodesigners explore the ways in which this emerging practice can offer pathways for noticing (Kim et al., 2023; Núñez-Pacheco & Poikolainen Rosén, 2024) and for creating symbiotic relationships between humans and other-than-humans, encouraging a heightened awareness of interdependence in them (e.g., Bell et al., 2024; Groutars et al., 2024; Ikeya et al., 2023; Kim et al., 2024; Liu et al., 2018; Ofer & Alistar, 2023, 2024; Risseeuw et al., 2024; Zhou et al., 2024). For example, guided by Bellacasa’s focus on care, Zhou et al. (2024) examined the materiality involved in caring for microorganisms in everyday life.

While much of the work of more-than-human design has been developed in theory, scholars have highlighted the importance of turning this knowledge into practice (Nicenboim et al., 2024; Poikolainen Rosén et al., 2024). To achieve this, it seems necessary to not only show examples but also to consider how this approach could be integrated into the tools that designers use. The potential of integrating MTH sensibilities in biodesign could promote inclusive, relational, and pluriversal practices that encompass the entire lifecycle of design, from ideation to application and multiple

lifecycles towards regenerative ecologies (Karana et al., 2023). In this context, biodesign communities play a crucial role in developing MTH sensibilities as they engage uniquely with living organisms, aligning closely with the hands-on, interdisciplinary, and materially attuned approaches practised by researchers in human-computer interaction (HCI) (Cheng, 2023; Cila et al., 2015; Oktay et al., 2024).

2.3 Our approach

We have thus far identified two key tensions faced by biodesigners: the interdisciplinary challenges of integrating biology and design practices, and the need to question the long-standing human-centred perspectives that have dominated the field, i.e., integrating MTH sensibilities to biodesign processes. In the following sections, we explore these tensions through a design-driven approach. By examining existing documentation practices and identifying underexplored niches, we aim to conceptualise a tool that makes these tensions more tangible and addressable.

As part of this initiative, we introduce a documentation tool to support interdisciplinary reflection and situated engagement in biodesign. The tool is designed iteratively in collaboration with biodesign scholars, focusing on four key dimensions: clarity in recording observations, openness to speculative thinking, attentiveness to MTH sensibilities, and structural coherence for usability. Through this iterative process, we aim to explore how documentation can serve as both a reflective practice and a generative space for fostering interdisciplinary dialogue and challenging anthropocentric norms within biodesign practices.

In the following section, we begin by reviewing existing documentation techniques across the fields of biology and design, with the aim of identifying potential insights into what practices might be retained or adapted—and for what purposes.

3 Documentation formats of biology and design

The distinct goals and methodologies of biology and design research need different processes and engage unique audiences. For that reason, each community has developed its own modes of documentation. Biology often emphasises precision, reproducibility, and verifiability; design prioritises rapid iteration, exploratory nature, and co-creation. Although these distinctions are common between these two fields, boundaries can remain fluid, and practices can overlap. For example, documentation through fieldnotes may allow more explorative and creative space, whereas design diaries can be more structured. Therefore, we do not imply a strict binary distinction, as our selected formats and proposed design reflect this fluidity.

3.1 Documentation in biological research

Laboratory notebook. A laboratory notebook is an essential tool for biological research, serving as a permanent record of experiments and observations (Kanare, 1985). It ensures accurate, immediate documentation of experimental methods, observations, and data in a systematic and verifiable format (Ebel et al., 1987). Also used as an organisational tool, a memory aid, and a legal record of intellectual property, a laboratory notebook safeguards the integrity and ownership of scientific ideas and findings (Schnell, 2015). By fostering accurate record-keeping (Thomson, 2007), it supports the reproducibility of experiments and provides an indispensable resource for writing detailed reports, interpreting results, and addressing future scientific inquiries. Traditionally, laboratory notebooks are designed as durable bound formats, comprising archival-quality paper material and ink to ensure the permanence

of records. As illustrated in Figure 2, their structured page layouts often include cross-ruling or horizontal grid formats to facilitate systematic data entry, accompanied by clearly delineated side margins and designated sections for author and responsible party signatures, thereby promoting organised and accountable documentation (Kanare, 1985).

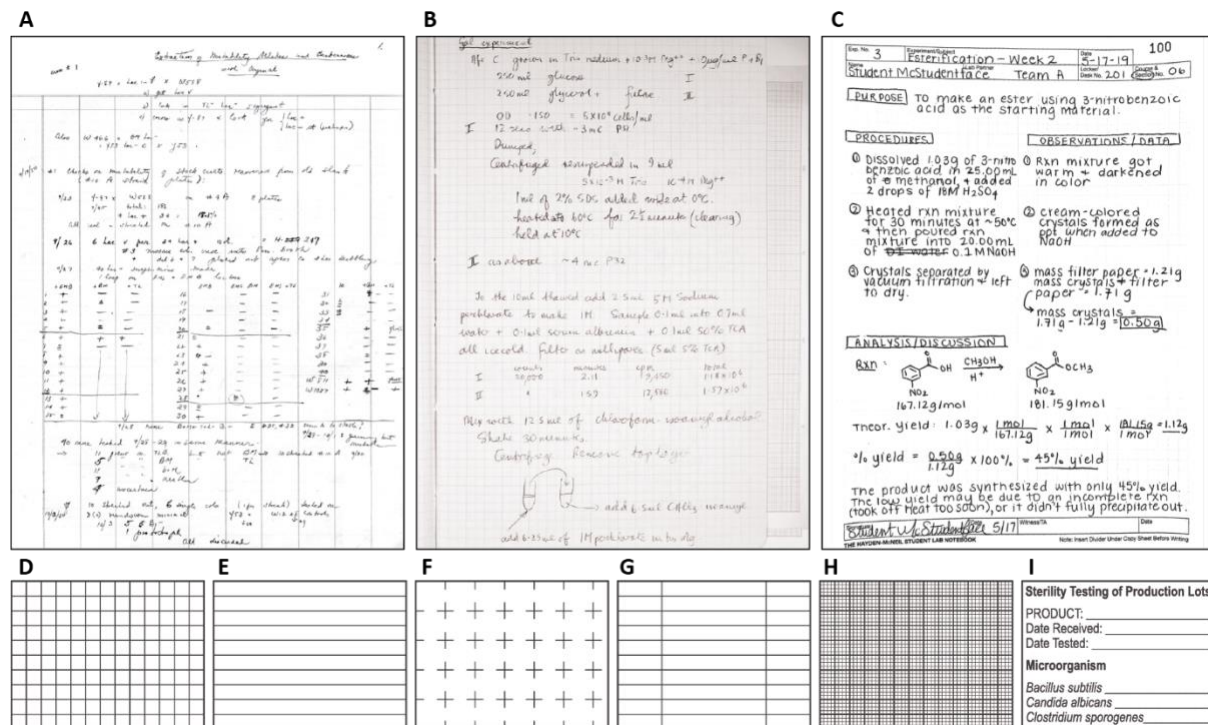


Figure 2. Laboratory notebook examples (collaged by the first author from original sources): (A) Experiment documentation of the discovery of temperate phage Lambda (λ), from Lederberg (1950). (B) Record of tracing viral DNA in bacteria using radioactive phosphorus, cropped from Brenner (1961). (C) Exemplary student notebook entry (Day et al., 2024). Common page design patterns of grids and lines, and layouts for recording specific test results: (D) 1/4-inch square grid. (E) Horizontal ruling. (F) Non-reprographic ink. (G) Columnar ruling. (H) Extra grid format. (I) Special-purpose test results page, adapted from Kanare (1985).

Fieldnote. A fieldnote, akin to a laboratory notebook, is another essential documentation tool in biological research, with both formats serving as permanent records of scientific inquiry. However, while laboratory notebooks focus on the structured, reproducible documentation of experiments conducted in controlled settings (Ebel et al., 1987; Kanare, 1985), fieldnotes capture the dynamic and often unpredictable conditions of natural environments. These records document observations, behaviours, and interactions among organisms, often employing narrative and richly detailed formats to complement and contextualise raw data (Canfield, 2011; Sterling, 2020). Like laboratory notebooks, fieldnotes provide a chronological record of scientific work, but their scope and format differ markedly. Contextual details such as location, weather, and ecological conditions are frequently included, as they are essential for interpreting findings (Sterling, 2020). Furthermore, drawing techniques, which play a crucial role in observational research and visual communication, allow researchers to focus on the intricate details of their subjects and enhance observational accuracy and visual communication (Keller, 2011). Unlike the rigidly bound structure of laboratory notebooks, fieldnotes—as shown in Figure 3—may adopt diverse formats, ranging from bound journals to pocket notebooks and data sheets, reflecting the varying goals and needs of fieldwork across disciplines (Canfield, 2011; Greene, 2011). Fieldnotes not only serve to document immediate observations but

also possess significant historical and scientific value as lasting references for future research and long-term ecological studies (Grinnell, 1910).

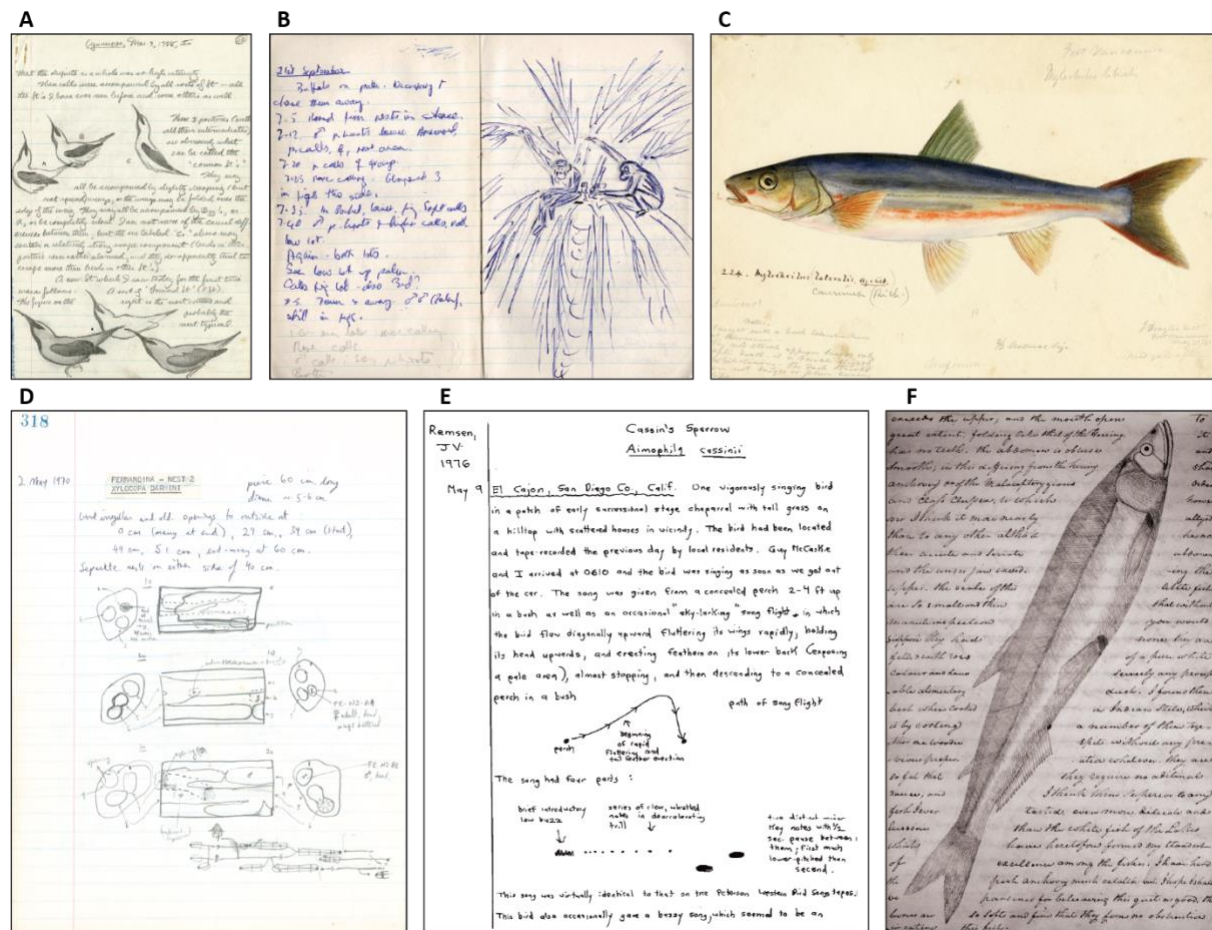


Figure 3. Fieldnote examples (collaged by the first author from original sources): (A) Observations of *Cyanerpes* on Barro Colorado Island (Moynihan, 1958). (B) Immediate record of chimpanzee behaviour in Gombe National Park, Tanzania, courtesy of Jane Goodall (1961, as cited in Gerber, 2017). (C) Drawing of Cyprinoid observed near Fort Vancouver (Drayton, 1841). (D) Entomological fieldwork record-keeping in the Galápagos Islands (Silberglied, 1970). (E) Example species account for an unusual species (Remsen, 1977). (F) Notes and illustration of *Eulachon* (*Thaleichthys pacificus*), cropped from Clark's expedition journal (Clark, 1806).

3.2 Documentation in design research

Design diary. A design diary is a retrospective documentation tool that records professional inquiries chronologically (Rieman, 1993; Zimmerman & Wieder, 1977), similar to fieldnotes in biological studies. When fieldnotes primarily focus on observational and contextual aspects of natural phenomena, a design diary emphasises the designer's personal experiences and decision-making (Pedgley, 2007). A design diary, where balancing written, visual, and structured elements, may include annotations, sketches, and other visual data that support reflective practices and document iterative processes, aligning with the dynamic nature of design work (Babapour et al., 2012). Design diaries are an effective tool for documenting longitudinal design practices (e.g., Hales, 1987), particularly help capture activities related to form generation, motivations, and the challenges encountered during the design process (Babapour et al., 2012), coupled with personal reflections (Brett, 1987; Moon, 1999). Depending on the research focus, diaries can take various formats, such as structured or unstructured

templates (e.g., Hyldegård, 2006), and may be presented in regular bound formats or more creative stationery designs (Figure 4).

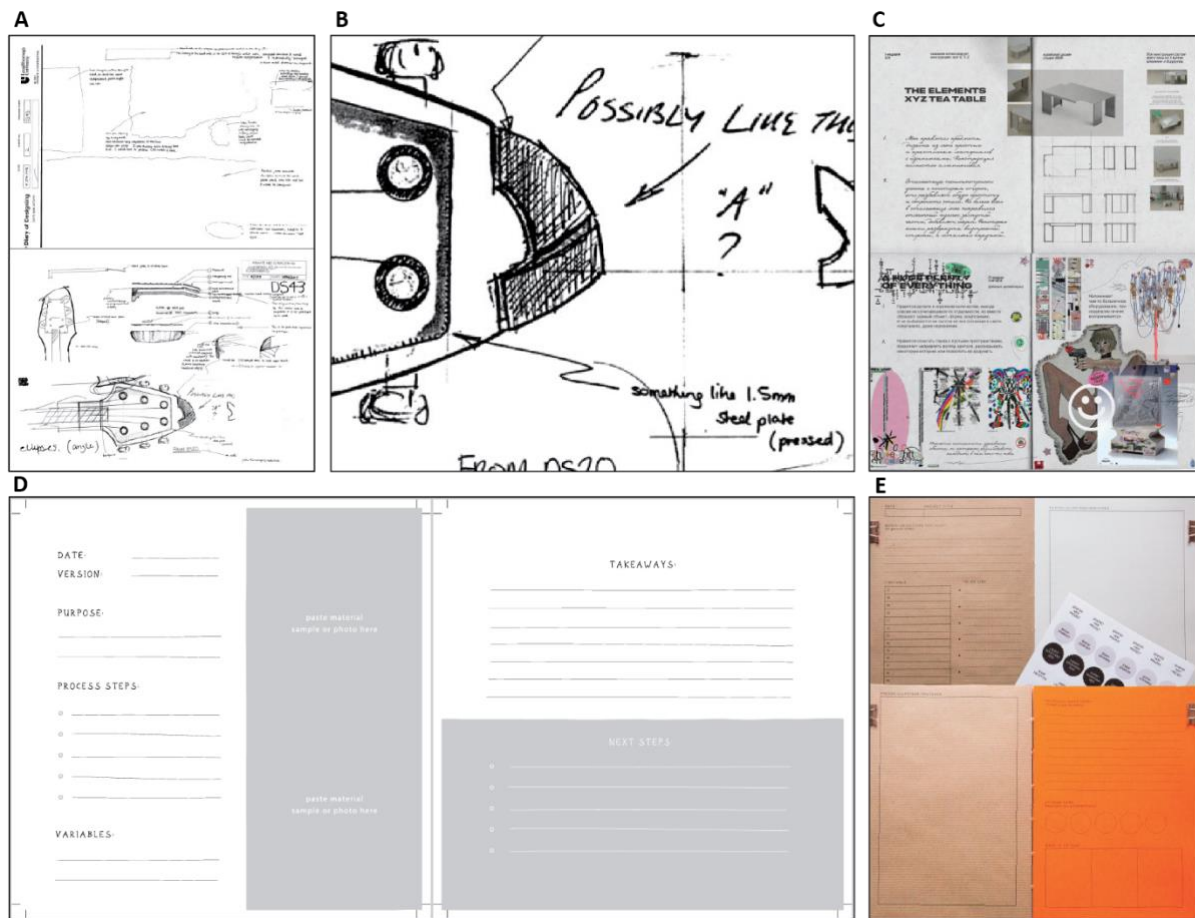


Figure 4. Design diary examples (collaged by the first author from original sources): (A) Completed 'tracing' stationery and corresponding sketch sheet. (B) Sketch associated with attention to materials and manufacturing (Pedgley, 2007). (C) Designer's diary formatted as a book artefact, adapted from Skachedubova (2024). (D) Materials Diary template (Materials Experience Lab, 2025). (E) Designer's journal for project focus and progress tracking, adapted from Tsoi (2015).

In biodesign, the use of a design diary has been particularly motivated by the need to bridge the temporal gap between the act of crafting and the realisation of the final material outcome—a process shaped by the unique temporality inherent to living organisms (Karana et al., 2018). Through meticulous documentation of even the most minor changes in ingredients or environmental conditions, the biodesigner developed a systematic understanding and a sense of confidence in managing the factors that influence the organism's vitality.

Sketchbook. A sketchbook is a versatile tool in design research and HCI, providing a medium for visual exploration and iterative documentation of the creative process. By allowing researchers to generate, refine, and record ideas without the pressure of achieving perfection (Lewis et al., 2024), the sketchbook method fosters ideation, iteration, and reflection, employing a low-fidelity yet highly effective approach (e.g., Newman et al., 2003) to exploring diverse concepts and design experiences (Lewis & Sturdee, 2024). The integration of sketching into research enriches this process, blending creative freedom with academic rigour to promote authenticity and deeper engagement, thereby benefiting both the creative and research domains (Koulidou et al., 2020; Sturdee et al., 2019). Unlike

research-driven works, the genuine place for creativity provides an unbounded space for thoughts and structures, often resulting in deeply personal and introspective works that remain distinct from utilitarian research imagery (Sturdee et al., 2021). Such practice encourages critical reflection on the intersections of aesthetics, culture, and technology, fostering questions and insights beyond immediate practical outcomes (Davis & Wentzel, 2021; Sturdee et al., 2021). By capturing the evolution of ideas—from initial brainstorming to prototype refinement—a sketchbook not only documents creative processes but also facilitates communication and collaboration (see Figure 5). It performs as a shared visual language, enabling effective dialogue and idea exchange within collaborative environments (Lewis & Sturdee, 2024).

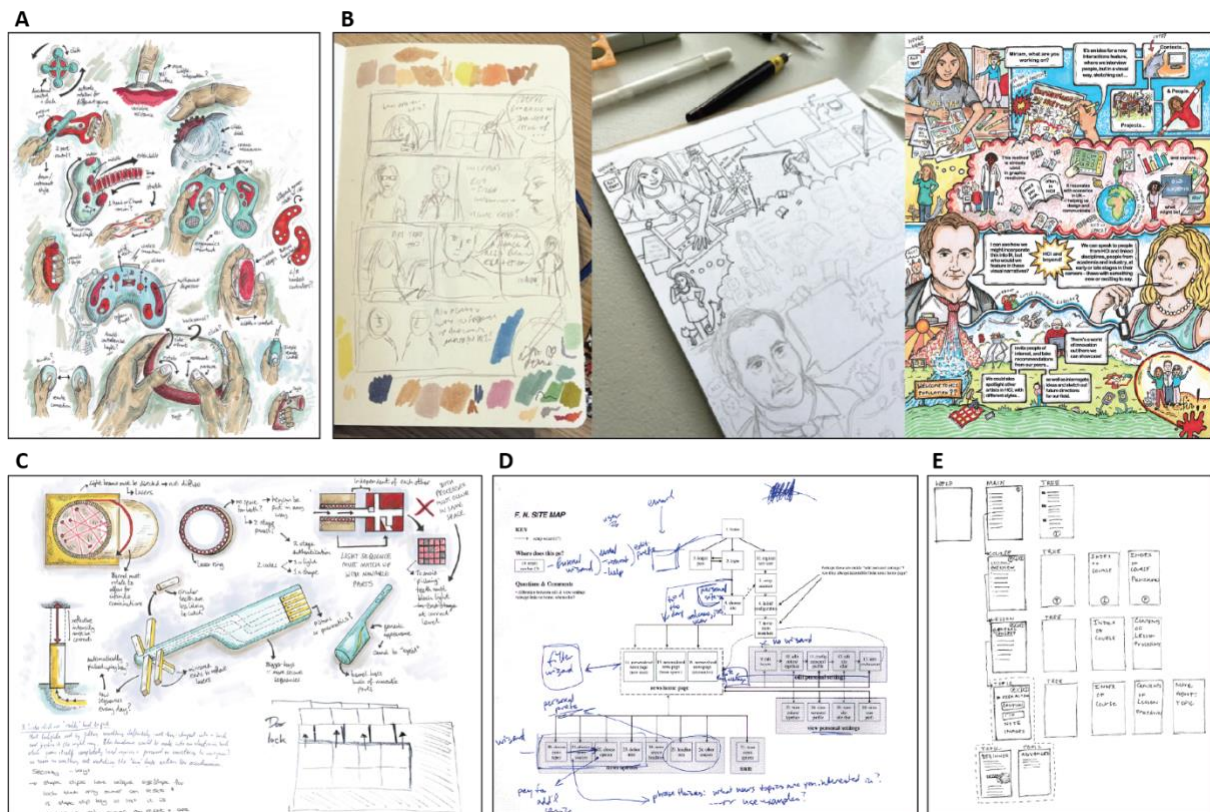


Figure 5. Sketchbook examples (collaged by the first author from original sources): (A) Iterative sketches and ideation for a console game controller, by Miriam Sturdee (Sturdee & Lindley, 2019). (B) From rough storyboard to full-page comic illustrating academic conversation, by Miriam Sturdee (adapted from Lewis et al., 2024; Sturdee, 2023). (C) Annotated sketches and ideation on shape-changing keys, by Miriam Sturdee, with further participant inputs (Sturdee & Lindley, 2019). (D) Collaborative use of paper via real-time co-located sketching and asynchronous annotation, shown in a printed and annotated site map. (E) Sketch by a designer participant depicting part of the CAD software tutorial's overall structure (Newman et al., 2003).

Annotated portfolio. An annotated portfolio is a pivotal documentation instrument in design research, particularly within the Research through Design (RtD) approach (Bowers, 2012), by facilitating the articulation of intermediate-level knowledge, a midway between general theories and specific instances (Höök & Löwgren, 2012; Löwgren, 2013). The integration of annotations—brief, precise notes using correct vocabulary—serves to clarify one’s comprehension (BBC, 2023). This methodological approach emphasises specific design features and conceptual insights, which enable designers to analyse and effectively communicate their processes and results (Bowers, 2012; Gaver & Bowers, 2012; Löwgren, 2013). In contrast to conventional documentation practices, annotated

portfolios establish an indexical relationship between annotations and design artefacts (Bowers, 2012). This relationship preserves the specificity of insights and their situated relevance to the design outputs, thereby avoiding abstraction that detaches insights from their originating context (Gaver & Bowers, 2012; Latour, 1987). In RtD, the annotated portfolio method aligns with values in both design research and HCI domains, including iterative learning, tangible inquiry, and situated reflection on practices (Gaver, 2012; Löwgren, 2013). Moreover, it addresses disciplinary tensions by embracing diverse research constructs, valuing the creation of design examples, and resisting rigid, overly scientific constraints on design research (Fallman & Stolterman, 2010; Gaver, 2012). By grouping and analysing multiple designs, the annotated portfolio format enhances generalisability while maintaining focus on specificities (Gaver & Boucher, 2024), demonstrating its suitability for exploring a variety of design scenarios (Gaver & Bowers, 2012). Its adaptable format allows for the inclusion of diverse media and presentation styles, further establishing it as an effective tool for capturing and disseminating insights derived from the Research through Design approach (Figure 6).



Figure 6. Examples of annotations addressing different perspectives on portfolios, focusing on users' experiences with the designs (Gaver & Bowers, 2012). ©Interaction Research Studio.

Critical journal & Contextual portfolio. A critical journal and a contextual portfolio, alongside the annotated portfolio approach, are potent documentation tools in design research, especially for Research through Design (RtD). The annotated portfolio format compiles visual artefacts with brief annotations that communicate design thinking concerning broader research themes, offering concise, artefact-focused insights. Instead, a critical journal and a contextual portfolio provide more extensive frameworks for documenting iterative processes, scholarly connections, and reflective insights (Sadokierski, 2019). Critical journaling prioritises chronological documentation, integrating contextual research, iterative mapping, and self/peer critique. It can enable collaborative, introspective reflection (for example, through visuals and prompts to capture nuanced details, Key et al., 2021) to generate knowledge in design research (Ofer & Alister, 2024). The contextual portfolio approach, derived from critical journaling data, synthesises design processes into formats conducive to academic

dissemination (see Figure 7). The portfolio integrates high-quality visuals, progressive overview maps, literature connections, and iterative design narratives that collectively illustrate academic contributions (Sadokierski, 2019). It possesses the flexibility to incorporate multimedia presentations and structure content for diverse audiences, ranging from disciplinary peers to interdisciplinary researchers. Collectively, these documentation tools enhance RtD by capturing tacit knowledge, iterative experimentation, and theoretical integration—key elements for advancing scholarly design research.

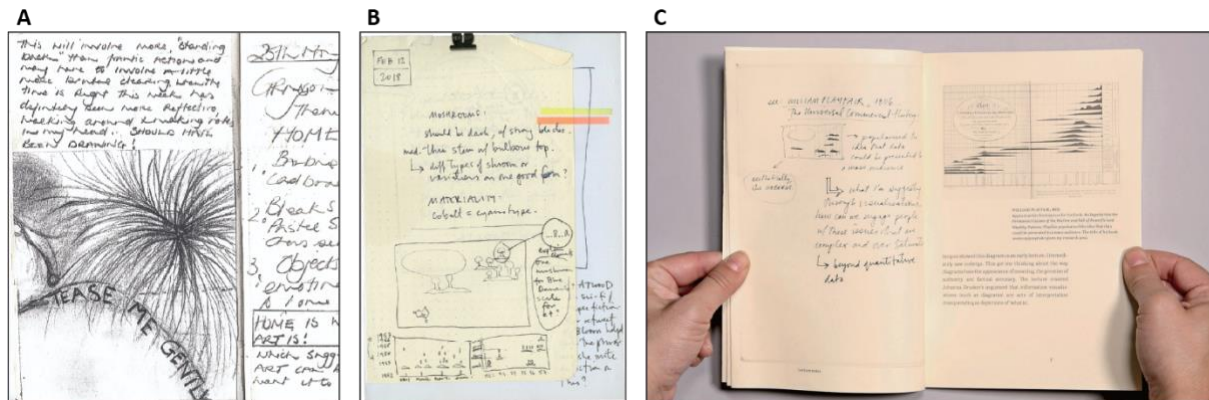


Figure 7. Critical journaling and contextual portfolio examples (collaged by the first author from original sources): (A) Critical journal entry by Fiona Browne, cropped from Key et al. (2021). (B) Personal reflections based on research into nuclear weapons testing in Maralinga, WA. (C) Contextual portfolio situating a design artefact alongside key insights from primary research, innovative design processes, and self and peer critique (Sadokierski, 2019).

3.3 Gaps and opportunities

Based on our observations, we identified key insights into balancing documentation practices in biodesign. Interpreted through our positionality and research goals, we organised these insights into three pillars that outline opportunities for designing a journaling tool to support reflective record-keeping across diverse practices and help biodesigners navigate MTH sensibilities.

Scientific Observation and Rigour. Working with living organisms in laboratory settings demands careful and methodical observation, often guided by scientific protocols. Accurate record-keeping, detailed experimental notes, and rigorous tracking of procedures are not only essential for reproducibility and verification but also serve as foundational inputs for biodesign ideation. Engaging with scientific methods enables a deeper, practical understanding of organisms thoroughly, often inspiring novel design directions. As such, documentation must preserve a space for fundamental scientific reflection, aligning with the values of precision, verifiability, and methodological clarity inherent in traditional biological research. Using techniques from laboratory notebooks and fieldnotes, such as hardcover binding with sewn and glued pages, makes it imperative to utilise durable, archival-quality materials for the permanent documentation of scientific inquiry. Additionally, maintaining structured formats from laboratory notebooks—such as a ¼” square grid pattern and typeset words—encourages a note keeper to capture essential information while facilitating chronological data entry systematically.

Creative Exploration. The design aspect of biodesign requires open-ended and creative approaches to inquiry. However, the iterative and speculative nature of design often conflicts with the rigid structure of scientific documentation, which can limit the expression of the fluid and emergent

qualities of design processes. Currently, many biodesigners rely on conventional laboratory notebooks, but these can constrain creative thinking. To support innovation, biodesign documentation should accommodate flexibility, rapid iteration, and collaborative exploration. Therefore, a hybrid documentation approach is needed—one that combines scientific rigour with the exploratory freedom characteristic of design. The drawing techniques from fieldnotes can support the visual capture of nuanced observations, while design diaries and sketchbooks enable longitudinal reflection, form development, and the elaboration of ideas. Annotated portfolios further reinforce the connection between insights and their design context, helping to ensure that interpretations remain grounded and communicable. Collectively, these methods operate beyond rigid structural constraints, allowing for greater flexibility in documenting complex biodesign processes.

Ethics of Care and Responsibility. Engaging with living organisms in design practice and designing within biological contexts introduces distinct ethical considerations. Each discipline's modes of documentation reflect its inherent values and objectives; for instance, biological research typically emphasises precision and accountability, whereas design documentation often prioritises critical speculation and reflective practice. When these two domains intersect as biodesign, these differing ethical frameworks may collide or intertwine, giving rise to new questions regarding human engagement with living systems. As an emerging interdisciplinary field, biodesign raises critical questions about how we treat, cultivate, and ultimately use or dispose of these organisms—questions that extend beyond the traditional ethical frameworks of either biology or design. This includes navigating the tension between caring for microbial subjects and adhering to safety protocols, as well as addressing broader issues of ecological responsibility and interspecies agency. In particular, because much lab-based biodesign involves living microorganisms, attentiveness to their distinctive qualities and ecological roles is central to advancing MTH sensibilities in the field. These concerns reflect a growing interest in MTH design and highlight the need for documentation tools that capture these aspects of biodesign practice, viewing them not as ancillary but as integral to the design process.

Despite these pressing needs, no existing documentation tool fully addresses the unique requirements of biodesigners working with microorganisms in laboratory contexts. Adapting the narrative and situated approach of fieldnotes can help capture the dynamic interactions between organisms and their environments. In parallel, critical journaling—with its use of visuals, prompts, and contextual reflection—can promote nuanced insights, illuminating the ethical and ecological dimensions central to biodesign practice.

In the next section, we will present our attempt to offer a new documentation format, namely the Reflective Biodesign Lab Journal, a specialised tool designed to support the documentation of biodesign experiments. This journal integrates scientific rigour, creative exploration, and ethical reflection that responds to the specific demands of laboratory-based biodesign. Crucially, it repositions documentation not as a passive act of record-keeping but as an active, generative medium capable of mediating disciplinary boundaries, eliciting tacit knowledge, and foregrounding MTH perspectives.

4 Reflective biodesign lab journal

The initial design of the Reflective Biodesign Lab Journal was developed through a synthesis of documentation typologies from both scientific and design disciplines. It features an intuitive and adaptable format structured around a foldable triple-layout, focusing on three core areas of biodesign: scientific rigour, designerly ways of knowing and working, and MTH sensibilities (see Figures 8 and 9).

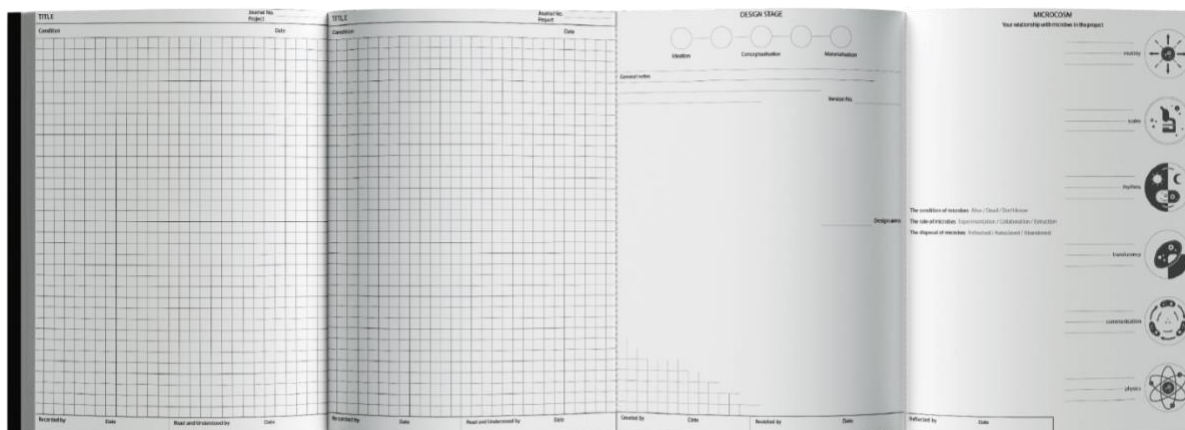


Figure 8. Opened triple-layout page of the initial Reflective Biodesign Lab Journal.

This structure draws inspiration from annotated and contextual portfolios, promoting interdisciplinary communication, reflection, and a balance between scientific rigour and creative exploration, as discussed in the previous section. The sequential integration of the three layouts is intended to foster natural, interdisciplinary reflective practices, facilitating fluid transitions across disciplinary boundaries—such as translating scientific language into design terminology—through concurrent engagement with scientific, design, and decentred journaling approaches. To encourage non-anthropocentric reflection grounded at the microbial level, the MTH section references the six design avenues outlined in the *Becoming microbes* concept by Kim et al. (2024), offering guidance for record-keeping that attends to microbial perspectives. The foldable structure enables sequential and layered documentation without page segregation, making it particularly well-suited to lab-based biodesign, where dynamic movement between scientific and creative modes is essential. Additionally, the journal is designed in B5 size, reflecting practical considerations for extensive documentation across diverse biodesign contexts.

No. 02
Sense like cyano

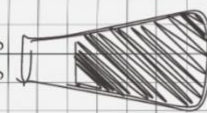
Date 01.09.2024

axis Assay
size approx. 100µm

in (5 ml)

and a filter
tube and store at 4°C

approx. 0.0750 L0
(light green)



medium (25 ml)
solution

lution
void any air bubbles

ppisa (1988)
et al. (1974).

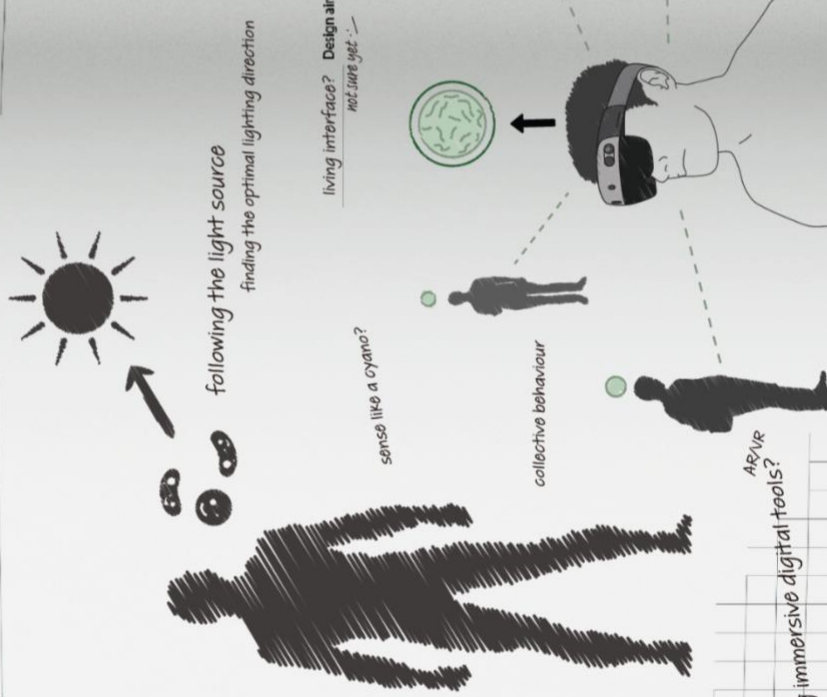
DESIGN STAGE

Ideation
 Conceptualisation
 Materialisation

Version No. 1

General notes Thoughts on UI using Cyanobacteria's phototaxis

What interactions can be imagined? Will it be implemented as a living interface-HCI?
→ Biological protocol-based exploration



following the light source
finding the optimal lighting direction

living interface?
not sure yet...

sense like a cyano?

collective behaviour

AR/VR
Using immersive digital tools?

Created by *Stachlman* Date 01.09.2024

Revisited by *Collaborator* Date 13.09.2024

Reflected by *Stachlman* Date 16.09.2024

MICROCOSM

Your relationship with microbes in the project

different speed moving towards the light source motility
slow for us, but not for them for better photosynthesis

understanding their temporality

trying to elicit their response to the light is this good for them? or am I spoiling them?

visible to human
micro & macroscopic scales BOTH

Can it be captured in nature too? Or is it occurring artificially in a laboratory?

in-situ

good
The condition of microbes (Alive) Dead / Don't know

The role of microbes Experimentation Collaboration / Extraction

The disposal of microbes (Refresh) Autoclaved / Abandoned

rhythms

translucency

communication

physics

+awareness

What are some UXs that can be beneficial to both?
maybe for the next step




Figure 9. Close-up of a completed Reflective Bidesign Lab Journal entry.

4.1 Insights into the design and use of the initial version of the journal

Following the initial design of the Reflective Biodesign Lab Journal, we made several design iterations to improve its use. The initial concept was created by the first author (biodesigner). This version was assessed by the co-authors (A2-4), with backgrounds in microbiology, biodesign, and MTH design. In addition, three biodesign practitioners (B1-3) from our own research group, actively working in a laboratory setting, assessed the journal and shared their insights through casual conversations and by annotating on the journal their opinions and feedback.

We canvassed constructive critiques, focusing primarily on four key areas: (1) the integration of a dedicated space for documenting scientific observation and rigour; (2) the provision of an open area facilitative to creative exploration; (3) the incorporation of ethics of care and responsibility to encourage MTH sensibilities; and (4) the overall structural composition, practicality, and readiness of the journal for use in laboratory settings.

After collecting and synthesising individual insights, the first author undertook further redesign efforts to refine the journal based on the feedback received, aiming to optimise its utility for biodesign practitioners engaged in reflective practice.

Scientific Observation and Rigour. The co-authors consistently affirmed the need to maintain a dedicated space for scientific observation to uphold biodesign's scientific rigour. A3 highlighted that the journal should serve as a personal record to promote reflection on one's practices while preserving the integrity of laboratory documentation. For example, elements like multiple date lines and queries about who read and understood the page—standard features in laboratory notebooks—were deemed unnecessary for a reflective personal journal and were recommended for removal (A2, A3). A2 and A3 also expressed concerns about the terminology used. Specifically, the term *condition* was considered ambiguous, and *protocol* was suggested as a clearer alternative (A3). Concurrently, B3 emphasised that the design of this section should not only uphold scientific rigour but also consider a deliberate connection with the creative exploration, as this section will inherently be the introductory page due to the journal's book-like structure.

Creative Exploration. This section was generally well-received as a space for ideation and iterative development. The co-authors viewed it as a bridge between empirical observation and critical thinking, supporting both agility and self-reflection. They agreed to designate this section for initial reflections on biodesign. A2 and A4 encouraged preserving the openness of the layout to foster creativity, in contrast to the rigidity of scientific recording. A3 suggested semantic refinements, recommending *design purpose* instead of *design aims* to better align with user intent and holistic objectives related to the design lifecycle. Additionally, regarding the design process indicator, A3 and A4 found the design process indicator unnecessary. Instead, they recommended adding extra headings such as *takeaways*, *challenges*, *opportunities*, and *next steps*, which are common in design record-keeping.

Ethics of Care and Responsibility. This section elicited a wide range of responses. The co-authors recognised it as a platform for fostering deeper and more advanced reflections. While the content was acknowledged for its role in promoting ecological awareness and multispecies ethics in biodesign (A2, A3, A4), the structural and visual presentation faced criticism for being more prescriptive compared to other sections (B2). A2 and A3 raised interpretive concerns, particularly about terms like *extraction*

and *disposal* within microbial contexts. They sought clarification on whether these terms described microbial activities or reflected anthropocentric interventions. A3 suggested reframing the questions as provocations to reduce ambiguity, directly referencing literature from MTH.

Furthermore, A3 and A4 advised adopting more generalisable language. Notably, A3 pointed out that *MTH sensibilities* function more like a goal, suggesting it be revised to focus on practices instead.

Most feedback emphasised the need to revise the layout of this section, suggesting it be transformed into supportive props. A3, A4, and B3 proposed reformatting it as a questioning sticker sheet and a bookmark, allowing biodesigners to engage more creatively and informally with their reflections.

Structure, Flow, and Practicality. A3, B2, and B3 observed a lack of visual and structural coherence among the pages, recommending the adoption of a unified design language to enhance the overall user experience. B2 noted that using dashed lines between sections was a helpful visual cue but suggested that more integrated transitions would improve clarity. A4, B2, and B3 also recommended incorporating more abstract visual elements to maintain consistency across different pages, instead of relying on limited visual connections or explicit descriptions.

In addition to concerns about layout coherence, the co-authors also raised issues related to the physical format and production feasibility of the journal. B1 and B3 noted that a foldable, three-page layout could be impractical due to manufacturing constraints and potential complexity, especially considering the initial design set for *B5* size per page. They suggested simplifying the journal to two core pages—one for scientific observation and one for design thinking.

In addition to these technical constraints, most feedback highlighted the need to revise the layout of the MTH reflection section. To facilitate a more creative and informal engagement, the co-authors proposed transforming this section into supportive tools, such as a questioning bookmark and a sticker sheet, initially proposed by B2 and B3 and refined by A2-4.

4.2 Final design

Through iterative development, the Reflective Biodesign Lab Journal has been refined to better address the practical and conceptual needs of biodesign practitioners operating within laboratory contexts. The original foldable triple-layout format has been restructured into a double-layout, which encompasses two primary sections: a scientific observation page and a semi-structured design reflection page. Furthermore, the central content of the MTH section has been reimaged as a detachable bookmark accompanied by a sticker sheet, providing users with portable and flexible tools for engaging in deeper ethical reflection (see Figure 10).

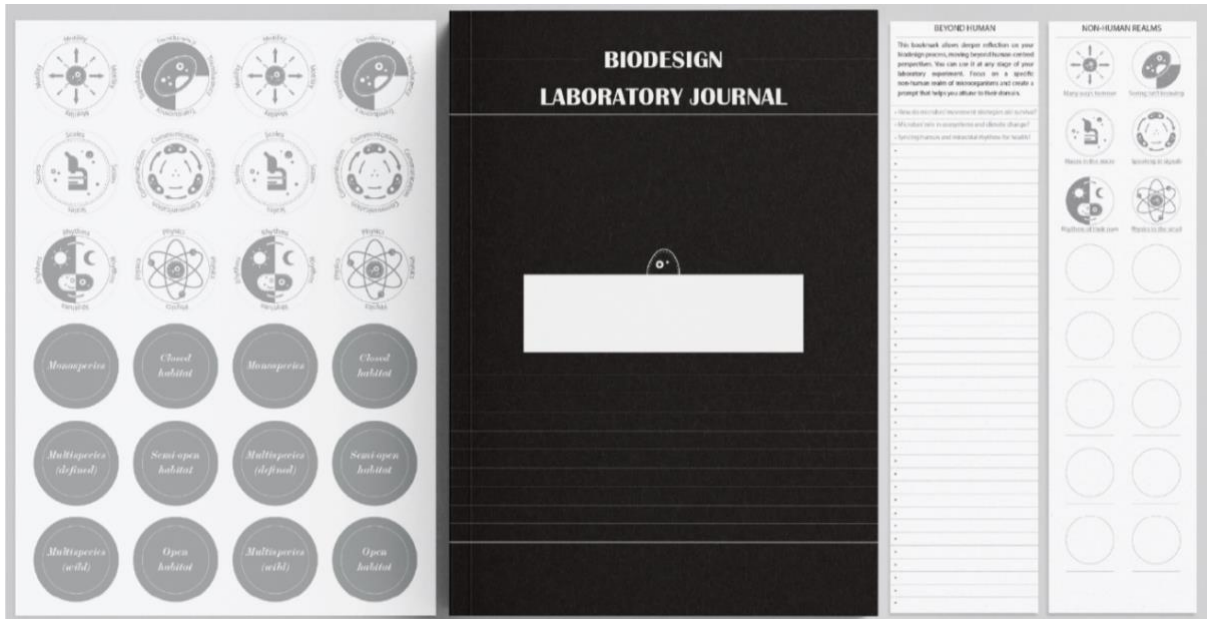


Figure 10. Final design of the Reflective Biodesign Lab Journal: Stationery layout featuring the journal, sticker sheet, and bookmarks.

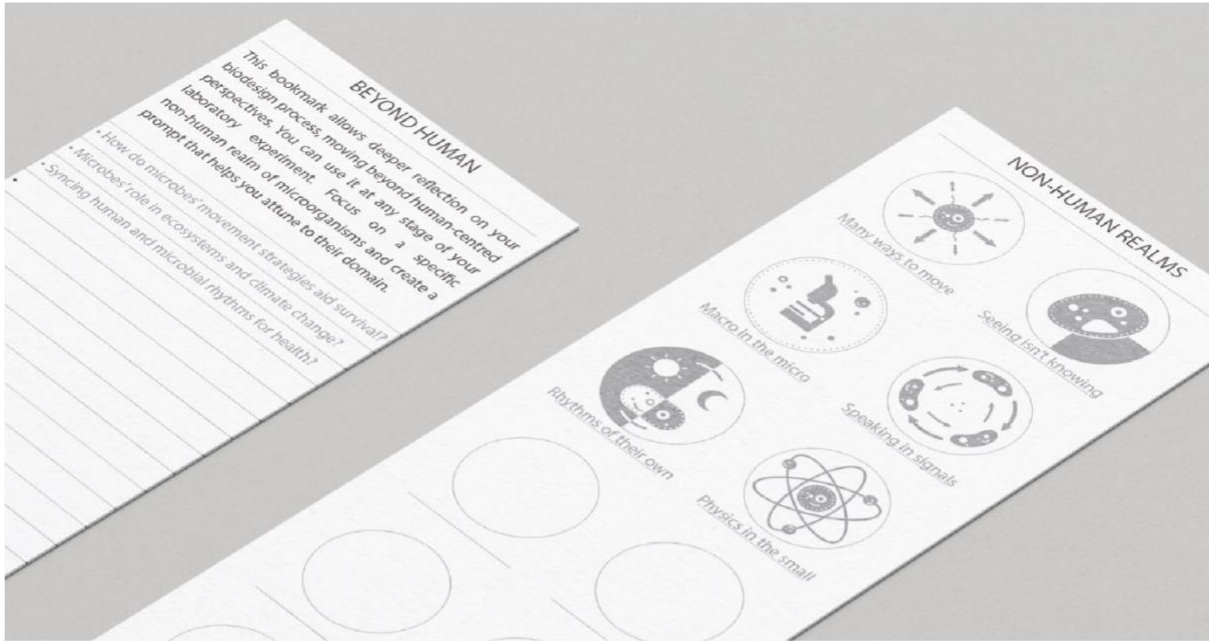
The journal's dimensions have been adapted from *B5* to *A5* size to enhance usability and portability, making it particularly suitable for everyday academic or professional applications. This modification facilitates more straightforward distribution and broader applicability across various institutional contexts.

Scientific Observation and Rigour. Drawing from the traditions of biological laboratory notebooks and fieldnote documentation, the scientific observation page is designed to support the accurate and methodical recording of experimental processes. It emphasises formal rigour, clarity, and verifiability to uphold scientific integrity.

Creative Exploration. The adjacent page serves as a flexible, semi-blank space intended to foster creative exploration and interdisciplinary communication throughout the biodesign process, from ideation to testing and evaluation. Influenced by fieldnotes, design diaries, sketchbooks, and annotated portfolios, this section encourages rapid iteration and reflective practice.

Ethics of Care and Responsibility. To preserve space for ethical introspection without overwhelming the journal's core structure, the MTH details have been redefined as a bookmark and sticker sheet. In order to promote non-anthropocentric reflection, the final design incorporates varying degrees of openness and multiplicity into artefacts involving non-human entities (Groutars et al., 2024). These tools invite users to engage with the ethical, ecological, and bio-political dimensions of utilising living organisms, particularly microorganisms, as design materials (Figure 11).

A



B

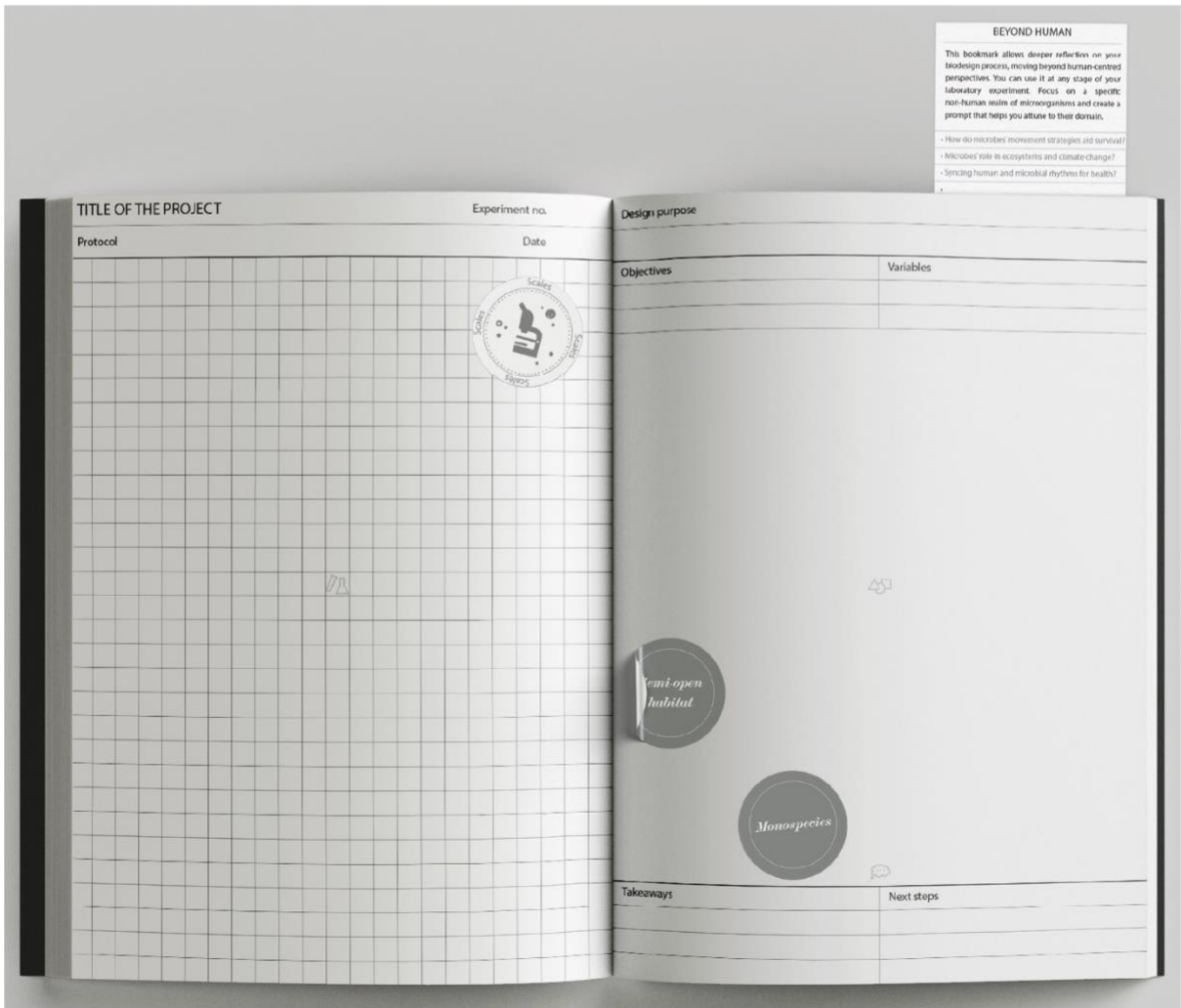


Figure 11. Final design of the Reflective Biodesign Lab Journal: (A) Close-up of the bookmarks. (B) Preview of the interior journal pages.

5 Concluding reflection: Advocating for plural biodesign practices

This journey has provided valuable insights into articulating the inherent tensions within biodesign, both across the broader discipline and within our internal biodesign research group. By critically reviewing the distinctive documentation designs employed across various fields, we identified the diverse purposes, functions, and contextual applications that shape these formats. Recognising the tacit knowledge embedded within each discipline was a significant challenge; however, our interdisciplinary team, comprising a microbiologist, an MTH design researcher, and biodesigners, successfully shared and surfaced one another's experience, contributing to a richer understanding of navigating the foundational aspects of biodesign documentation methods.

Rather than offering a comprehensive account of documentation practices, our aim has been to share a glimpse into the journey that led to our proposal—what Höök and Löwgren (2012) describe as contributing *intermediate-level knowledge*. We intentionally use the term *documenting* to highlight the hands-on, situated process of research through tools like journals, notebooks, diaries, and portfolios—avoiding *reporting*, which suggests a focus on dissemination over practice.

Our exploration also recognised substantial variability in documentation practices across organisations and individuals. This variability was shaped by factors such as research security requirements, practical necessities, personal preferences, established traditions, the use of mixed platforms, and varying levels of digitisation. Even in highly systematic and rigorous fields such as biology, documentation practices demonstrated considerable diversity. The increasing trend towards digitising laboratory notebooks underscores the importance of critically revisiting the Reflective Biodesign Lab Journal in our subsequent studies.

While interdisciplinary tensions within biodesign have been consistently acknowledged since the field's emergence, the role of documentation remains underexplored in the existing literature. To address this gap, we drew on our team's collective empirical expertise to propose an initial framework for biodesign research documentation. Our findings, however, are constrained by the scope of this study: the prototype was tested with a small number of participants, half of whom were members of the co-author team and the other half from our current research group, and feedback was collected through informal conversations. These limitations underline the need for further testing with a larger and more diverse user base, including biodesigners from different backgrounds, to better understand potential differences between intended and actual use of the Reflective Biodesign Lab Journal.

Designing a template also carries the risk of being overly prescriptive. Future iterations could synthesise various decentring methods from biodesign, HCI, and MTH design into a flexible, comprehensive scaffolding, clarifying how this documentation format complements existing approaches while supporting diverse practices. Building on this foundation, we plan to conduct workshops, focus groups, and studies across varied biodesign contexts, including educational settings, where reflective documentation could serve as a pedagogical tool for fostering situated and interdisciplinary practice. Through these efforts, we aim to further refine the Reflective Biodesign Lab Journal, ensuring it balances scientific rigour, creative exploration, and MTH sensibilities, while remaining adaptable to the diverse needs of the biodesign community.

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