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Webbing Clothes Moths from pest to opportunity: A reflective case study in interdisciplinary design-biology collaborations

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Abstract: This manuscript presents the first set of insights from the reflection on a case study which involved early-stage design-biology interactions in a collaboration between two PhD candidates - a designer and a biochemist - investigating the potential of the Webbing Clothes Moth enzymes to support novel approaches for the deconstruction of wool in the context of bio-based processing for the circular economy. From the interview and reflective practice on the collaboration a novel concept emerged, common sedimented ways of knowing, which we define as shared approaches that have been acquired independently through previous experiences during the lifetime of an individual. This concept enabled proximity between the two collaborators, here taking the form of visualizations to support the dialogue on complex discipline-specific content and its delivery to a public audience. This paper demonstrates that a translational dimension can emerge in early-stage design-biology collaborations despite the infancy of the PhD candidates' research.

Keywords: translational practice; proximity; design-biology; collaboration

1. Introduction

The large environmental impact of the fashion and textiles industry on our planet has been widely acknowledged. Designers, scientists, and industry stakeholders are harnessing the potential of biological systems to transition to a more sustainable industry. Hence the need for the collaboration and integration between the wider design discipline - inclusive of fashion and textiles - and Science, Technology, Engineering and Mathematics (STEM) fields. Designers have powerful imaginative abilities; however, if their ideas and vision go beyond design disciplinary knowledge, they are required to seek collaboration with STEM researchers and experts to translate their "design fictions into design facts" (Toomey & Kapsali, 2014, p. 5).

Simultaneously, design has been proven to be a valuable strategy to achieve innovative outcomes in science (Mackay, 2023), to lead on multi-stakeholders' materials innovation projects (i.e. Tubito et al., 2019) and to play a translational role both turning scientific discoveries into impactful real-world applications (Page & John, 2019) and within complex multidisciplinary projects (Hornbuckle, 2022).

The interdisciplinary collaboration that is the foundation of this paper involves two PhD candidates, a design researcher with a background in fashion and textiles design ("designer") and a biochemist ("biochemist"). Both are involved in the investigation for the use of Webbing Clothes Moths (Tineola bisselliella) for biobased processing of wool derived end-of-life textiles. This investigation was initiated during the designer's master project, with the designer seeking the collaboration with the scientists to translate the designer's design vision into facts and builds on the conceptualization of enzymatic process as support to closed-loop textile circularity through using their specific ability of depolymerize end-of-life textiles (Ribul et al., 2021). Webbing Clothes Moths, while considered a household pest, have the unique ability to degrade wool, a keratin-based fiber highly resistant to degradation (Wang et al., 2016). The investigation of this unique ability and the potential of using the isolated enzymes for the deconstruction of wool is relevant in both the textile and biological disciplines as an opportunity for biobased processing of fibers. The textile industry wool waste represents a niche segment of the global fiber production, however, "finding unconventional uses and feasible processing technologies to obtain value-added products" (Rajabinejad et al., 2019, p. 1440) may offer an opportunity to harness both under-valorized raw wool and end-of-life textile wool as feedstocks for other sector products and commodities.

The two PhD candidates are based in two Research Centers partnering in the UKRI Textiles Circularity Centre (TCC). The TCC is an interdisciplinary Consortium led by the Materials Science Research Centre (MSRC), Royal College of Art in collaboration with other university partners - including the Centre for Novel Agricultural Products (CNAP), Department of Biology, University of York. The TCC is turning post-consumer textiles, crop residues and household waste into renewable materials. The designer is based at the MSRC while the biochemist is based at CNAP.

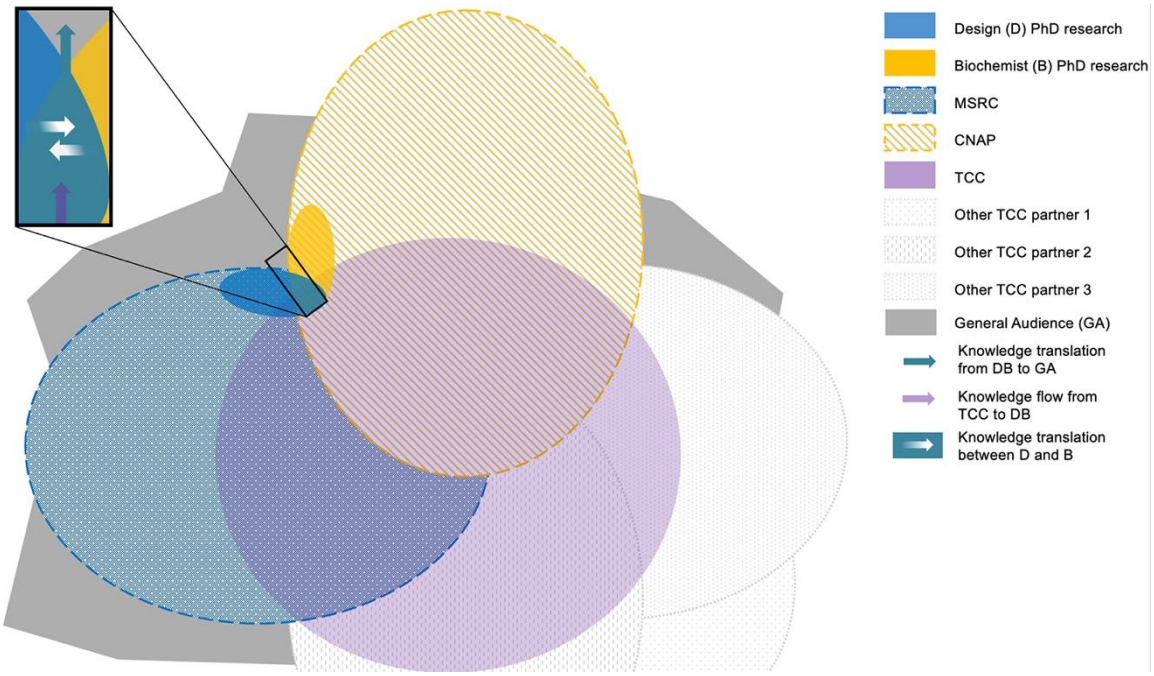

Figure 1 Representation of the intersection of the two PhD candidates research within their relative institutions and the TCC. It highlights how the two PhD candidates were involved in knowledge translation processes. They had to translate disciplinary specific knowledge and content bidirectionally during their interactions and to translate their research to a general audience during two public disseminations events. The arrows represent knowledge flows and knowledge translation involved in the collaboration.

This paper reports and discusses the reflection on emerging insights drawn from the early-stage collaboration between the biochemist and the designer. In this paper we demonstrate that even at a very early-stage of research a translational dimension emerged in the collaboration between a designer and a biochemist. The collaboration entailed a research placement, an interview and two public dissemination events. The collaboration activated multi-directional knowledge flows (Figure 1), which are increasingly relevant not only to foster innovative outcomes but also to translate research to non-experts. Although translational research encompasses translation not only to a wider audience but also to application, this paper will not focus on the latter due to the early stage of research. To aid in translation, building "proximity" (Hornbuckle, 2022; Hornbuckle & Prendiville, 2022) in interdisciplinary interactions is an important aspect. By reflecting on the interactions of the biochemist and designer we suggest that identifying common sedimented ways of knowing can address cognitive distance and catalyze "cognitive proximity" (Hornbuckle, 2022) between collaborators with different disciplinary backgrounds. The conceptualization of common sedimented ways of knowing is the main contribution of this paper and its emergence is explored throughout the paper. We define common sedimented ways of knowing as shared approaches that have been acquired independently through previous experiences during the lifetime of an individual. Here visualization is the approach from common sedimented ways of knowing that the biochemist and designer share. By collaboratively reflecting and identifying common sedi-

mented ways of knowing between the designer and the biochemist coupled with establishing a common vocabulary and promoting milestones in shared objectives, gaps, and "chasms" (Page & John, 2019, p. 690) were bridged between the two collaborators thus facilitating translation to a wider audience.

2. Background literature

2.1 Knowledge translation, translational role, and proximity

In design research literature there are two main perspectives regarding design as translation mechanism (Simeone et al., 2017). A linear one which entails the translation in the various design steps, i.e. designers translating idea into a sketches and prototypes, and a more involuted one where design is a means of translation in "complex and ambiguous interactions and negotiations among various stakeholders" (Simeone et al., 2017, p. 9). Design as a means of translation and connector between science and other actors seems tightly linked to the design-science relationship (i.e. Remington et al., 2007). The importance of translation as one of the acts that scientists and other actors need to enact to enable collaboration to advance science is acknowledged in Star and Griesemer (1989). In complex collaborative projects translation is beneficial to reduce barriers and difficulties posed by actors with different "forms of knowledge or understanding" (Hornbuckle, 2022, p. 2). Human factors such as compatibility, background and approach to collaboration have been acknowledged as focal points in the translation process (Hornbuckle, 2018). Translation design practice has been defined as a vehicle to enable cognitive and social proximity between experts, stakeholders and the wider audience of multidisciplinary complex projects that address technological innovation (Hornbuckle, 2022), thus highlighting how building proximity is an important aim in translational design. Proximity is intended as the capacity of different participants and stakeholders collaborating to share the same perspective, to understand each other's perspective, communicate and co-create and therefore innovate (Hornbuckle, 2022). Certain design approaches, such as visualizing knowledge, inherently have a translational dimension which can be adopted in building proximity between stakeholders to aid knowledge exchange and enhance mutual understanding by addressing divergent knowledge (Hornbuckle, 2022). Similarly design outputs such as prototypes can support the translation of theoretical and technical aspects which can be more easily understood by multiple stakeholders (Simeone et al., 2017). The process of knowledge translation entails new knowledge being processed, interpreted, and transformed in line with the necessities and interests of the specific stakeholders and application context (Simenone et al., 2017). Translational research was defined as "the activity of supporting basic scientific discovery to become applied research activities, and then again supporting the applied research to be adopted, at scale, within the community" (Page & John, 2019, p. 690-1). One of the fundamental skills of translational designers is the ability to fluctuate between concerns of practice, evidence, reflection, and knowledge (Page & John, 2019). Both the PhD candidates navigated aspects of practice, evidence, reflection, and knowledge in the collaboration even if at a very early-stage. By re-

flecting on the understanding which has been implicit in their actions and interrogating procedures enacted (Schön, 1994) during the collaboration the two PhD candidates identified shared approaches. The two PhD candidates were involved in knowledge translation processes as shown in Figure 1. They had to translate disciplinary specific knowledge and content bidirectionally during their interactions and to translate their research to a general audience during two public disseminations events.

2.2 Ways of knowing

In transdisciplinary learning it is important to look at how people acquire knowledge in the context of their disciplinary areas, understating approaches, motivation, and culture (Hepburn, 2022). Different disciplines usually entail different ways of knowing and interdisciplinary collaboration may entail conflicting ways of knowing (i.e. McCarthy & Fishman, 1991). Ways of knowing can be "designerly", "artistic" and "scientific" (Cross, 1982, p. 3); "emotional", "rational", "subjective", "objective", "familiar ways of knowing", "old ways of knowing" and "disciplinary ways of knowing" (McCarthy & Fishman, 1991, p. 421-422); or can embrace "systematicity" or "the attitude of doubt" (Yanow, 2009, p. 584). Ways of knowing in general address the modes through how we do know and understand something or "methods of enquiry" (Cross, 1982, p. 3). Designerly ways of knowing are distinct from scientific ways of knowing (Cross, 1982). Design and science differ in their methods, their phenomenon of study and values: scientists approach problem solving by analysis, while designers by synthesis (Cross, 1982). Moreover, designerly ways of knowing are linked to the "concrete/iconic mode of cognition" (Cross, 1982, p. 11) considering that design supports the advancement of non-verbal communication. Knowledge and knowing are strictly connected to the individual's execution of their practice (Carlile, 2002). Although ways of knowing are plentiful and diverse depending on various factors, there are categories of ways of knowing that transcend disciplinary domains (McCarthy & Fishman, 1991), for example, ways of knowing that adopts visual means as found in our case.

2.3 Sedimented ways of knowing and tacit knowledge

We define sedimented ways of knowing as being approaches acquired through previous experiences during the lifetime of an individual and of which an individual is not necessarily explicitly aware until this awareness is elicited. The word sedimented is borrowed and adapted from the term "sedimentation"(Merleau-Ponty & Landes, 2012) where the term is linked to the "mental operations, which allows us to count on our acquired concepts and judgments, just as we count upon the things that are there and that are given as a whole, without our having to repeat their synthesis at each moment" (Merleau-Ponty & Landes, 2012, p. 163). The act of "learning by doing" and the difficulty in conveying the obtained knowledge via explicit methods such as verbalization is a description of tacit knowledge (Polanyi, 2012; Polanyi & Sen, 2009). There are several contributions that designers can bring to scientific research, one of these is the unlocking of tacit knowledge (Peralta, 2013; Rust, 2004), co-design activities are effective ways to uncover tacit forms of knowledge in daily life (Page & John, 2019). Tacit knowledge "is subjective and experience based (...) cannot be expressed in

words, sentences, numbers or formulas(...) it is context specific, involving that it can be transferred only through the socialization process" (Simeone et al., 2017, p. 6). According to Cross (1982, p. 8) designers' awareness of their problem-solving processes is tacit knowledge ''they know it in the same way that a skilled person knows how to perform that skill". If tacit knowledge is unique to everyone (Rust, 2004), we believe the same for sedimented ways of knowing as each individual brings a unique cognitive and experiential legacy. However, it can be assumed that individuals belonging to the same disciplinary background may carry a similar collection of approaches to cognition, what McCarthy and Fisher (1991, p. 460) would call "disciplinary ways of knowing" due to a presumably similar educational background.

2.4 Boundary objects and visualizations as tools in interdisciplinary collaboration

In the translation between different points of view, the boundary object occupies a pivotal role (Star & Griesemer, 1989). Boundary objects can be abstract or concrete and they can have different significance in different communities, however, their structure has a universal connotation that is identifiable and becomes instrumental to translation (Star & Griesemer, 1989). Boundary objects can assume different forms, they can be visualization but also materials samples (i.e. Wilkes et al., 2016). Boundary objects can enable "two-way interdisciplinary translation" (Wilkes et al., 2016, p.11). Boundary objects can aid advancing conversations, helping individuals collaborating effectively across boundaries often given by divergent knowledge, training and sometimes objectives (Black, 2013). In Ribul and de la Motte (2018) visualization was identified as a transdisciplinary method which improved the communication in interdisciplinary collaboration. Visualizations reveal imperceptible processes with the aim of aiding and reinforcing comprehension (Bonsiepe, 2000) and representation systems have an acknowledged role in the advancement of thinking and knowledge (Rust, 2004). Visualizations can be considered as a medium to attain a scope and can enhance the understanding of the context, convey views, and unfold narratives (Masud et al., 2010). Diagrams and visualizations representing intricate phenomena, despite often resulting in a lack of remaining merely descriptive, often become generatively (Sevaldson, 2013). This collaboration highlighted how visualizations - specifically diagramming and mapping - was a common approach adopted by the biochemist and designer in the translation of knowledge and acted as boundary objects. Visualizations through sketching were a key shared tool for conveying knowledge and communicating complex disciplinary specific principles and processes. Visualization acted as a bridge to build proximity between the two disciplinary areas. Although often a visual language is linked to the designer's way of communication, we observed that using visuals was adopted by both the biochemist and the designer for communicating discipline specific content.

3. Methods

The TCC catalysed the introduction and aided maintenance of the designer and biochemists' collaboration via several means. The collaboration entailed a research placement, two public

dissemination events, an interview conducted by the designer with the biochemist at approximately a year from the beginning of the collaboration and a reflection phase.

3.1 Research placement

The interdisciplinary collaboration between the two PhD candidates was initiated and implemented through a series of meetings both online and in-person as well as a research placement of the designer in the biochemist's laboratory. Ahead of the beginning of the collaboration the designer conducted a literature review in the field of interdisciplinary design-science methodologies. The research placement entailed approximately 22 days of visits spread over six months. During the research placement the designer adopted traditional field research methods such as conversation, note-taking, and photography (Hall, 2020), which were refined and adapted throughout the research placement. The research placement was undertaken to start addressing the lack of scientific skills and knowledge of underpinning processes in the isolation and characterization of Webbing Clothes Moth enzymes from the designer's side and to build proximity between the two PhD candidates alongside to creating a mutually educative collaboration.

For scientists, tacit knowledge is gained through experience in the laboratory. Therefore, the only way for the designer to gain part of the knowledge required to translate their vision into facts was to participate in the laboratory setting as well as collaborating with scientists. Concurrently from the designer's perspective "there is an understanding of how the knowledge gained through practical experience can contribute to the knowledge of the field and how this can be communicated through creative practice" (Page & John, 2019, p. 699).

A milestone during the research placement was a day-long mapping workshop between the biochemist and designer at the initial stage of the research placement which offered the opportunity for the candidates to map out their research as envisioned at that time, including a temporal dimension, and pointing out potential areas for interactions between the two's research projects. Figure 2 shows the biochemist mapping and timeline of experiments with subsequent notes added by the designer to sign-post experiments conducted during their visit. The workshop aimed to facilitate the understanding of the respective PhDs' research as well as contextualize and situate the experiments the biochemist was working on. It also offered an occasion to clarify scientific terms and disciplinary areas, aiding in the generation of a common vocabulary. Mapping in a workshop setting fostered a dialogue between the participants and hence collaboration (Sevaldson, 2013).

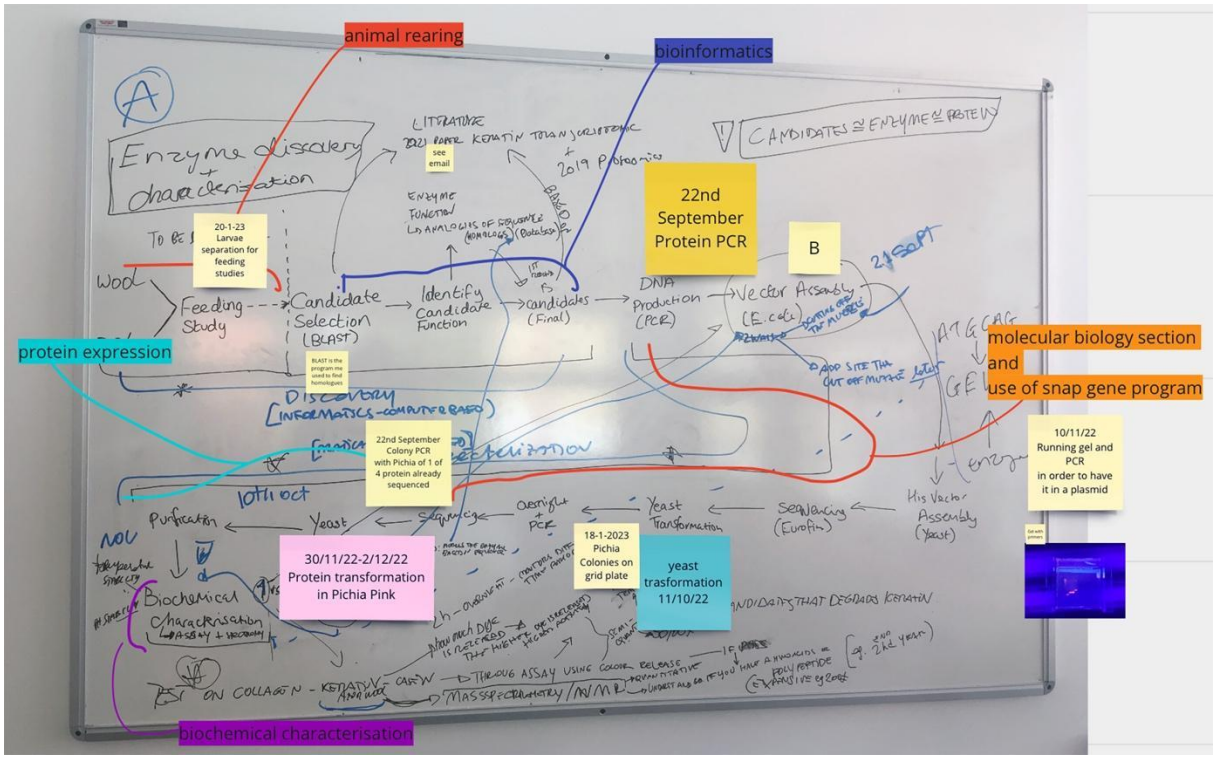

Figure 2 Biochemist's process mapping, as drawn by the biochemist during the day-long workshop between the two PhD candidates. Notes, digital post-it and pictures were added by the designer during following visits of the research placement to position the experiments conducted.

3.2 Interview

The designer interviewed the biochemist to review and understand their perspective, the added-value and challenges perceived in the collaboration as part of the "analytical activities" suggested by Peralta (2013, p. 65) in the investigation of design-science collaborations. Interview is also one of the social sciences and design research methods used in translational design practice to build proximity (Hornbuckle, 2022). The interview followed a semi-structured form, it was conducted remotely, and questions were shared in advance as it entailed extracts of the designer's own placement review including visualizations in reflection of the interaction during the research placement. The interview was used as a tool to countercheck some of the designer assumptions and outcomes of their individual reflection on the research placement interactions. The contents of the interview were transcribed and further discussed with the biochemist. The interview played a pivotal role in the discovery of a common sedimented way of knowing approach, visualizations. For example, the biochemist stated:

> "(...)in A level in nutrition and science one of the things that they very much do in that field is mapping processes through flow diagrams. For me, that's incredibly useful, because I sit down and break down the process into each step (…). For me, visualization and writing something out is better than a kind of verbal explanation".

Moreover, it was acknowledged by the biochemist in the interview that "[visualization] was a good technique that both of us could use. Both of us could understand. This is something we do have in common". Thus, highlighting how despite different disciplinary backgrounds a common trait was found in the adoption of visual language for knowledge translation as legacy of previous experiences.

3.3 Public dissemination events

The two public dissemination events were considered milestones of the collaboration. They offered the opportunity to work on a shared objective and to translate discipline specific complex concepts and early-stage research into compelling presentations which could be easily understood by a public audience. Considering that in translational research a central point is the consideration of how research can be communicated beyond the academic environment and design's supporting role (Page & John, 2019), this was an important dimension enacted by the two PhD candidates. The preparation for the public dissemination events were instrumental in the development of a common vocabulary. This was due to the reflective nature of the preparation due to the audience attending the event which included a mixture of lay people as well as members of the design and biology communities. The generation of slides and scripts for the sessions created a reflective space that allowed for the identification and generation of common vocabulary as well as the identification of complex concepts which required to be translated in an easily understandable language. Without these events, the establishment of a common vocabulary may have been more difficult and slower as they acted as a platform for reflection and consideration of collaborative research dissemination.

3.4 Reflection

Reflection is an important skill in translational design (Page & John, 2019). Reflection-in- action is a pivotal method that allows practitioners to cope with situations of uncertainty, instability, and uniqueness (Schön, 1994). Reflective practice is intimately linked to learning from experience. It is through reflection that a practitioner can surface the tacit understanding that has grown up in the experience of their practice and make new sense of the surprises and uniqueness that their intuitive performance had led to (Schön, 1994).

Building on Schön (1994), Thompson and Pascal (2012) defined reflective practice as the process of thinking about the work undertaken which encompasses reflection-in-action and -on-action. This blends theoretical and practical themes and issues by integrating them and opening a dialogue (Thompson & Pascal, 2012). It endorses practical knowledge, skills and experiences and acknowledges them as important elements in learning. Whereas reflexive practice refers to "a personal review of past experiences to make sense of the present" (Alley et al., 2015, p. 427). Reflexivity acts out the attitude of testability and it is extended to the methods. Practice should be an 'emancipatory practice' open to new ideas, new perspectives, and new challenges (Thompson & Pascal, 2012). Reflective and reflexive practices were conducted by both the PhD candidates, individually and collaboratively and it was

through the reflection on the interaction and the interview that the concept of common sedimented ways of knowing emerged.

4. Discussion

4.1 Translational dimension in the PhD candidates' collaboration

Figure 3 highlights how in the collaboration between the two PhD candidates' aspects emerged that are relevant to translational design practice: proximity, knowledge translation, establishing a common vocabulary and reflection. We add to these concepts a new one: common sedimented ways of knowing which emerged in this collaboration. Considering that "the translational designer works at the interface between industry and their fundamental research peers in the academy" (John & Page, 2019, p. 12), we found that even at a very early-stage of their PhD research, the biochemist spontaneously envisioned the designer role in the collaboration as translational. For example, when the biochemist was asked how they envisioned the collaboration they answered the follow:

> "Mainly it would come through the knowledge of the applications (…) it was very much sort of from the information industry is to what they did or didn't want, having it work for everybody, we need to know what everybody wants and what we're looking for specifically (...) if we can speed up that reaction from industry point of view (...) that's good as well."

Moreover, the biochemist already acknowledged that despite the collaboration with the designer not affecting their day-to-day laboratory work, the collaboration may have impacted the way they were doing research or the way they would word it. According to Page and John (2019) characteristics of a designer working in a translational role are the ability to work with uncertainty and complexity, to embrace iterative investigation, able to master synthesis and interdisciplinary communication, disseminate research to a wide and general audience, to ask naive questions and to encourage comfort with risk. All these aspects were encountered and navigated by both the two PhD candidates. Thus, giving the biochemist an unforeseen translational design role. For example, both the PhD candidates collaborating at the early stage of novel scientific research were operating in a complex and uncertain environment. They had to synthesize the envisioned process of their research to each other, for example in the mapping workshop setting and to the general audience during the public dissemination seminars. Moreover, the biochemist had to synthesize and transfer biological principles and underpinning knowledge for the experiments to the designer during the research placement. Reciprocal interrogations took place during the collaboration to clarify aspects of each other's discipline, being novice in the other's discipline.

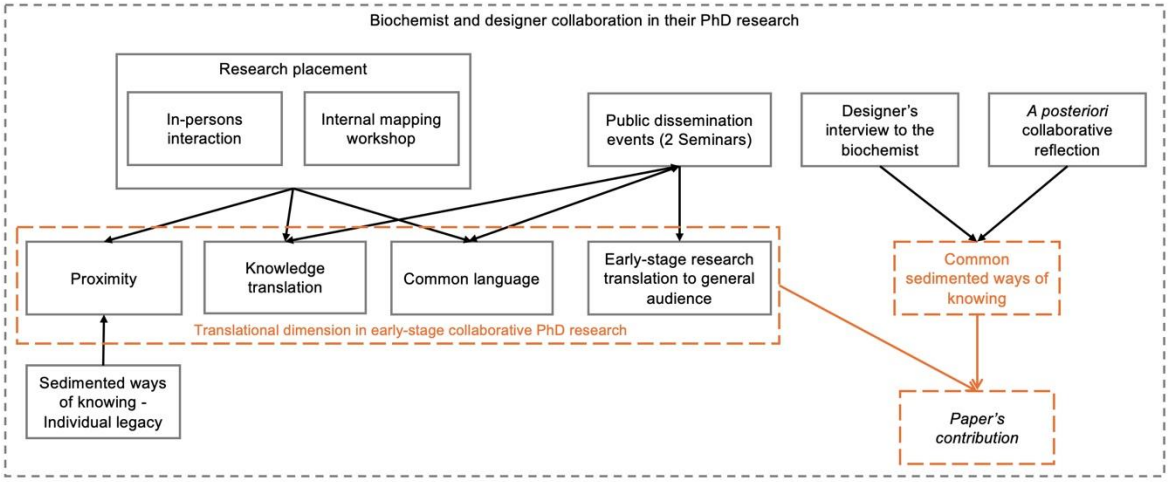

Figure 3 This diagram illustrates how the various methods used in the collaboration enabled inputs relevant to concepts of translational design practice. The interview and the collaborative reflection enabled the identification of common sedimented ways of knowing. It also highlighted the translational concepts already present in the PhD candidates collaboration: the research placement and mapping workshop forged proximity between the two candidates, required bidirectional knowledge translation and the establishment of a common language; the public dissemination events required the two PhD candidates to translate complex principles and knowledge to a wider audience but also acted as a platform that enabled the refinement of a common language between the two collaborators; the interview and the subsequent reflection resulted in the acknowledgment and emergence of the concept common sedimented ways of knowing.

In the collaboration both the PhD candidates embraced translational roles bidirectionally and synergistically worked to translate their research to the general audience and members of the design and biological fields. Drawn from our experience, the collaboration and proximity between a designer and a biochemist activated multi-directional knowledge flows which are increasingly relevant not only to foster innovative outcomes but to translate research into applications and to non-experts.

4.2 Common sedimented ways of knowing

Common sedimented ways of knowing builds on the perspective that in the translation process the focal point is the human factor (Hornbuckle, 2018), finding a common ground despite different disciplinary backgrounds helps establish proximity in collaborations. Although there might be a closeness between the concept of tacit knowledge and sedimented ways of knowing, we suggest that there is one major difference. Tacit knowledge refers to acquired knowledge that is inexplicable and only enact-able. We define common sedimented ways of knowing as approaches shared between individuals which have been acquired through previous experiences during the lifetime of an individual and of which an individual is not necessarily explicitly aware until this awareness is elicited. This concept was uncovered during the collaboration by mutual utilization of visualizations for conveying knowledge and communi-

cating complex disciplinary-specific principles and processes within the interdisciplinary design-biology collaboration. As well as acting as a bridge to build proximity between the two disciplinary areas (Figure 3).

Often a visual language is linked to the designer's way of communication, we observed that using visuals was a spontaneous method adopted by both the biochemist and the designer. For the biochemist, this sedimented way of knowing was acquired actively by previous experience and unconsciously utilized in the present. The biochemist had received previous education in food science, which exposed them to similar visualization techniques as those found in design, re-enforced by a visual learner mindset. This sedimented way of knowing became the common ground between the designer and the biochemist, therefore a common sedimented way of knowing, facilitating not only the interaction, the transfer of knowledge and translation between the two but also with the general audience.

4.3 Defining a common vocabulary

In interdisciplinary design-science collaboration, communication is often highlighted as one of the areas which needs improvement (Hornbuckle, 2018; Ribul & de la Motte, 2018; Wilkes et al., 2016). Establishing a common vocabulary, clarifying discipline-specific terms, making it clear if words are used interchangeably and selecting only one are necessary initial steps in interdisciplinary collaboration (Hornbuckle, 2018; Hornbuckle, 2022). Creating a glossary is a suggested first step in multi-disciplinary collaborations (Hornbuckle, 2022). Although a proper glossary was not created, terms were clarified in an organic way through the collaboration. Different methods helped define a common vocabulary: the research placement and the mapping workshop provided an opportunity to clarify scientific terminology to the designer as well as working on the collaborative presentation for the public dissemination event enabled clarification of design research language to the biochemist. The interview enabled the acknowledgement by the biochemist that learning and understanding the use of design research language was one of the most valuable, but also most challenging aspects of the collaboration, "(...)trying to get my head around that which was the most difficult, because it's entirely new language I've never seen before, but the same time the most valuable (...)".

Figure 4 shows two examples of the clarification and selection process of terms that are used interchangeably in biochemistry: "enzymes" was chosen over "candidates" and "proteins", while "vector" over "plasmid". In biochemistry "candidates", "enzymes" and "proteins" are used interchangeably as enzymes are types of protein and these enzymes are the candidates of interest for developing the bio-based processing of keratin. The term enzyme was chosen as this is the key component underpinning the development of the bio-based processing technique. Similarly, all plasmids are vectors however, mostly only bacteria can uptake and utilize plasmids, given the biochemist's work is carried out across two organisms the term vector was selected to describe any genetic material. These selected terms were also taken forward for the public seminars to prevent confusion with a lay audience.

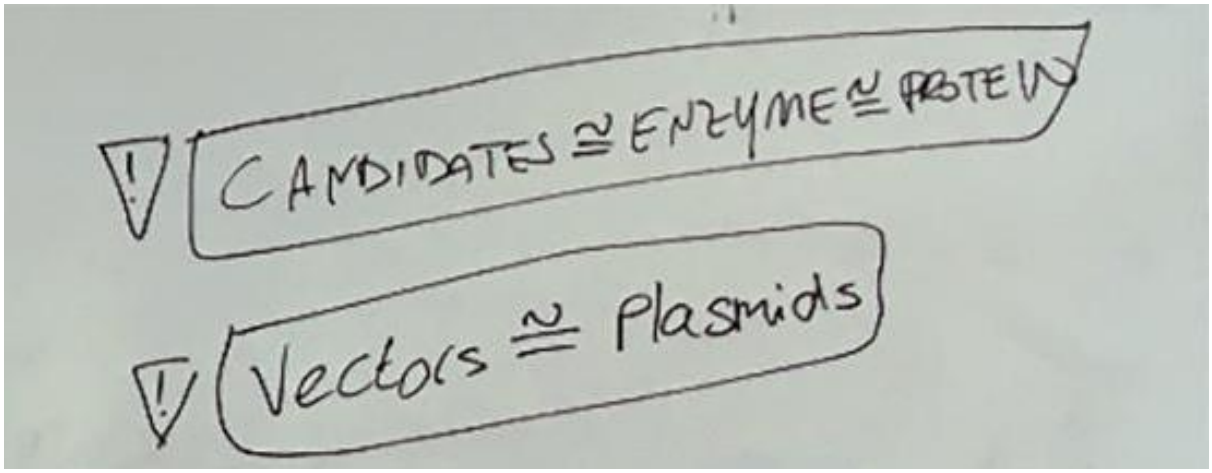

Figure 4 Snapshot illustrating two examples of establishment of common vocabulary during the mapping workshop at CNAP.

5. Conclusions

In this paper we have introduced common sedimented ways of knowing as a new concept to build proximity in interdisciplinary interactions and to enable translation. The identification of common sedimented ways of knowing is tightly related to a reflective practice enacted by the participants of the collaboration. The interview enabled the identification of a shared approach in ways of knowing between the biochemist and the designer despite their different training background. Through collaborative reflection the shared approach was defined as a common sedimented way of knowing. Through this paper we acknowledge how finding common sedimented ways of knowing could be a means to establish proximity between two collaborators with different disciplinary backgrounds. We also demonstrate how a translational dimension is already present in early-stage design-biology collaboration between two PhD candidates (Figure 3). Establishing a common vocabulary allowed for the understanding of each candidate's research and field; while the discovery of a common sedimented way of knowing, in this case visualizations, aided conveying knowledge from one discipline to another and presenting complex concepts and visions to laypeople and members of the design and biological fields. If the research placement pushed the designer into the biochemist field, the collaborative writing towards this paper pushed the biochemist's knowledge to the design research field. We understand that there are limitations of this case study considering the infancy of research discussed and that the interactions of two PhDs are the beginning of their research process, while in literature translational design is defined and discussed in complex multi-stakeholders' projects and in contexts where the scientific research was already carried and needs commercial translation. We would like to conclude with a question, if translational aspects are already considered and embedded in early-stage PhD research and collaboration, could this accelerate scientific research impact?

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