

Translating disciplinary practices for *trans-sentient* collaboration

G. Mauricio Mejía^a, Roger F. Malina^b, Yumeng Xie^c, Alex García Topete^d

^{a, c} Arizona State University, ^{b, d} University of Texas, Dallas.

^{a, c} Tempe, AZ, ^{b, d} Dallas, TX, USA

^a mauricio.mejia@asu.edu, ^b rmalina@alum.mit.edu, ^c yxie80@asu.edu, ^d topete@utdallas.edu.

Abstract- Summary

This paper is an inquiry about how the field of translation studies and translation-related issues could provide good practices for enabling successful transdisciplinary collaborations. The focus is on transdisciplinary practice and research, which bridge experts in very different disciplines that do not share success criteria, exact methodologies or dissemination methods. We argue that either disciplinary translators or collaborators with disciplinary translation skills will support better transdisciplinary outcomes. After reviewing literature and reflecting on diverse translation concepts and experiences, we developed 10 preliminary heuristics that collaborators from art and sciences can use to improve teamwork with transdisciplinary-outcome goals. This paper is also an experiment in language and transdisciplinary translation and collaboration. The background of the authors includes design, astrophysics, education, and art.

Keywords

Transdisciplinary collaboration, translation studies, knowledge translation, disciplinary translation, heuristics, art-science.

Introduction

The word ‘universe’ has the same root as the word ‘university’ in the western world, which is derived from Latin. Even though university discipline branches are apparently independent, they are connected by the same *roots* - assist humans to manage knowledge for perceiving themselves and the environment, as well as for exploring the validity of concepts about the world. Disciplines have their own methods, terminology, thought patterns and academic cultures. When practitioners from different disciplines collaborate, they realize the need to communicate and agree on the methods, terminology, concepts, processes, and practices. Multiform collaboration among disciplines such as cross-, multi-, inter-, and transdisciplinary collaboration are increasingly playing decisive roles in the process of both knowledge production and problems solution. Strengthen the connection, interaction, and sentient communication are prerequisites for transdisciplinary collaboration. The aim of this paper is to identify what we can learn from fields of translation to improve the power of perception of others’ work and suggest heuristics as good practices for transdisciplinary collaboration. We address the concept of

translation broadly and include cultural, cognitive, technological, and emotional issues of language and literary translation, knowledge translation, transmodal translation (or translation through sentence), and disciplines of disciplinary translation.

Nowadays, higher education is having more cooperation among disciplines, and disciplinary boundaries are getting more blurred (O’Reilly, 2004, p. 724). This phenomenon is mainly triggered by increasingly complex and inter-related problems in the real world. Those complex problems cannot be solved by any one discipline alone and require multiple disciplines with a shared theoretical understanding and an agreed interpretation of knowledge (Gibbons, 1994, p. 28). Therefore, more communication, interaction, and collaboration across borders of disciplines are needed. It is a trend that disciplinary boundaries are positioned in an iterative process, and are broken then restructured. Breaking down silo mentality among disciplines should be a key - sometimes even the first- step for transdisciplinary collaboration, which requires collaborators to be equipped with a un-disciplinary mindset. The different thought patterns and cognition are influenced by multiple factors, while language is a significant element. What often happens is that they take place simultaneously and build upon each other. Collaborators in practice or research should be encouraged to move beyond the comfort zone, which could help to reveal more subtle internal relations between facts. We argue that the more languages and ‘disciplines’ we speak, use or translate, the more we are able to work with others and address broader challenges of society.

A translation operation is not just about translating words or sentences but translating meaning, acknowledging intent, and recognizing contexts. Within the translation professions this is often thought of as interpretation rather than translation, which has been a debate in the translation studies tradition for centuries, from Schleiermacher in the Romantic period (Venuti, p. 103-104), to Walter Benjamin (1927) at the start of the 20th century, to Bachmann-Medick’s (2013) idea of a “translational turn”, just to name a few. In fact, as Bachmann-Medick (2013) explains, *translation* beyond the context of literature shouldn’t be “diluted into mere metaphor” but rather considered as “an analytical category with a new emphasis on the often challenging shifts between different (cultural) levels and contexts, whether in intercultural transfers or in interdisciplinary activities” (pp. 188-187).

The same framework applies when translating among disciplines, particularly when false cognates are used. Language translation practices require specific skills that go

beyond basic knowledge of grammar and vocabulary. Translators need to have a deep understanding of conceptual frames, cultural differences to translate meanings rather than words for making communications possible and effective. When collaborating, communication between people from different disciplines or backgrounds also requires continuous translation of meanings. It is insufficient to share only terminology or methods. Therefore, is there a need for disciplinary translators? What is the nature of disciplinary translation? Should collaborators develop translation skills? Where and how can such training be acquired? In the following sections, we will discuss concepts of translation studies and experiences of language translation. Then, we suggest potential heuristics that can be used to enhance transdisciplinary collaboration.

Translation and culture

The practice of translation depends on a deep understanding of the cultures of the source and/or receiving contexts. For example, if a literary work of an English writer is translated into Chinese, the source context may be the United States and the receiving context may be China. Bassnett (2007) explained that, in the last two decades of the twentieth century, translation studies shifted from drawing on literary and linguistic approaches to using the tools of cultural studies (pp. 13-14). She presented some implications of this cultural turn and some of them can be transferred to heuristics that support transdisciplinary collaboration. These selected implications include power relations, the historical situation, and text grids, which are discussed below.

First, power relations are implicit when there is an exchange between two cultures. The cultural turn in translation has unveiled the relevance of equity issues such as gender and racial hybridization (Bassnett, 2007, p. 15). Further, some may see literary translation as an aggressive act of colonization (p. 20). Disciplinary interactions also involve differential power relationships, which implies that disciplinary translators or collaborators with translation skills are more equipped to deal with dominance and equity issues of teamwork. In other words, disciplines that may be considered weaker or developing, or disciplines that have gendered associations could be empowered by translation skills to have a fair voice in collaboration. Ideally, the translated text (or transdisciplinary outcome) can also be seen as a third relational entity different from the source and receiving cultures (Simon, 2011).

In terms of the historical situation, Bassnett (2007) argued that a translated work might or might not influence the receiving context depending on the position of the context (p. 17). For example, China has had a recent boom of works translated from English as part of its modernization process, which was different in the past because China was not as open to exchanges. For transdisciplinary collaboration, this issue could be interpreted as the preparation that some collaborators may need to receive, use, or embed insights from other disciplines. A collaborator should be situated in a position, where there is more likely to be permeated by other collaborators. In some cases, collaborators from a particular discipline and particular approaches to the discipline might need preparation activities to get ready for

disciplinary exchanges. For example, design professionals that have a traditional form, expression, and craft-oriented practice may be resistant to collaborate with business professionals that are more interested in the profitability of design. Although business professionals have become interested in the concept of design thinking, not all designers are aligned with the meaning of this concept in business and not all business professionals are familiar with the concept of design thinking in its detailed and various methodologies.

The last relevant implication is text grids. Bassnett (2007) explained that text grids are “patterns of expectations that have been interiorized by members of a given culture” (p. 19). Some cultures share more grids (e.g. Spanish and French) than others (e.g. English and Chinese). These grids have methodological and political implications for translation practices. Similarly, some disciplines share some concepts, methods, and philosophies (e.g. sculpture and dance - dance is seen as a flowing sculpture, and sculpture is seen as a solid dance) more than others (music and chemistry). Therefore, particular transdisciplinary collaborations will require different methods, sensible precautions, or *cultural exposure*. For example, marketing professionals could be asked to sketch and visualize concepts or campaigns before they work with graphic designers in creating visual merchandising strategies. Likewise, graphic designers could be asked to work at a point of sales before they collaborate with marketing professionals. These activities of cultural exposure could help foreign collaborators.

An exemplar of this approach is the research of Tina Qin, an IT professional at a major banking institution. She is also a Ph.D. candidate at the University of Texas at Dallas. The focus of her thesis is the application of metaphor theory to data visualization. As articulated above simple devices like ‘grids’ or ‘tree structures’ are ‘patterns of expectations’ and implicit biases which often take the forms of ‘metaphors’; e.g. the branches of a tree do not reconnect, but the roots do. Modeling using grids can be a way of imposing power relations. Simple examples include tree of knowledge versus a network of knowledge metaphors. Conceptual Metaphor Theory (CMT) provides a broad foundation for structuring visual communication. Research has been done such as image-schemas, frames, prototypes, conceptual metaphors and metonymies to mental spaces. Conceptual Blending Theory (BT) elaborates on the integration of the elements to form complex ideas. The metaphoric mappings and connections revealed by these theories provide an integration of network structure for visual technology. Big Data visualizations that use a variety of framing conceptual metaphors could provide new approaches. Every visualization integrates implicit biases that are often difficult to make explicit.

Based on this category of translation and culture, we developed the following preliminary heuristics for transdisciplinary collaboration:

- [Power relations] *Reduce power dominance between disciplines by equipping collaborators with translation skills and tools.* Specifically, collaborators with less “disciplinary power” need abilities to translate their disciplinary languages to make their discourses accessible to others.

- [Historical situation] *Prepare collaborators to receive insights from other languages and determine the potential disciplinary state or maturity of participants to source or receive discourses.* For example, collaborators can negotiate the goals of the transdisciplinary work and realize the approach needed. Then, everyone is a position of interest for translating disciplinary discourses.
- [Text grids] *Understand the approaches, methods and political implications of every discipline to identify similarities and distinctions in cultures of work.* The awareness of similarities/distinctions in the way every collaborator works will help to understand each other.

Language and cognition

Echoing Wittgenstein's dictum that "the limits of my language mean the limits of my world" (Wittgenstein, 2014, sec. 5.6), the study of language has historically explored how language influences worldviews, particularly in terms of the Sapir-Whorf hypothesis that has been a contentious topic among linguists and cognitive scientists for decades (Krippendorff, 2006, pp. 63-64). Translation, however, tends to challenge any notion of "universal language" when revealing the subtle cognitive influences/biases inherent to languages and the cultures they inhabit; for example, the Eskimo have a plethora of names for the color white (Ortega y Gasset, 2012), the Hopi structure grammar devoid of time/tense, or Spanish build direction and gender into its syntax and grammar. Likewise, disciplinary worldviews, which include the technical languages of the respective domains (as Ortega y Gasset also pointed out in the 1930s), develop biases and blind-spots too about reality that need to be understood and translated when sharing knowledge (Risku, 2013).

Bilingualism has proven to have cognitive effects that benefit such speakers, ranging from enhanced executive control (Bialystok, 2011), improved creative processes (Hommel et al., 2011), better memory, and delayed neuronal aging (Bak et al., 2014). The benefits, in theory, would also positively affect transdisciplinary capabilities and inclinations, which could explain why most transdisciplinary practitioners belong to hybrid communities (Simon, 2011, p. 51). For example, we notice that Leonardo journal authors are often bilingual or polyglots, similarly to how artistic avocations influence scientific discovery and polymathy (Root-Bernstein et al., 2008).

In more anecdotal instances, we reflected on our own cultural experiences with language and the cognitive features of language and translation. We are four co-authors that speak four languages total: English (all), Spanish (Mejía and García Topete), French (Malina), and Chinese (Xie). First, bilingual individuals with life experiences in two contexts are often weak formal translators; however, the acculturation process of their past experiences positions them to understand complex meanings in two languages. Therefore, successful transdisciplinary collaborations may require the participants to be willing to undergo 'disciplinary acculturation,' which often takes time for a process of adaptation. One of the authors is bilingual

French/English (Malina): he was born in France, he acquired English at home from his parents but French at school and playing on the street with childhood friends; as a result, he easily articulates certain concepts in French, but not as well in English; and vice versa. Yet, he can serve as a mediator to enhance communication and collaboration between collaborators that speak English and French.

Based on this category of *language and cognition*, we developed the following preliminary heuristic for transdisciplinary collaboration:

- [Bilingual cognition] *Increase language skills of other disciplines in the collaborators to allow them to produce hybrid outcomes.* As individuals become bilingual in the language of two disciplines they are better prepared to understand meaning differences, bridge connections, and facilitate work with larger teams.

Translation and technology

The study of language and translation itself has been a transdisciplinary endeavor for decades, involving linguistics, anthropology, cognitive science, sociology, forensics, and classical humanities (Palmer and Neumann, 2002; Porter, 2009). More recently, the use of technology in translation has developed, which has active participation from the general public. For instance, tracking and documenting slang usually requires crowdsourcing to get the meanings and uses "right" (or as close to real-world uses as possible), which is done thanks to thousands of active amateurs, Internet databases, and tech-savvy scholars in what amounts to a combination of "citizen science" and digital humanities (Davidson and Goldenberg, 2004). More recently Cris Kubli at the University of Texas at Dallas has been developing methods to make AI software 'culturally sensitive' which brings 'AI beings' into translation studies.

The surge of digital humanities provides some of the best examples of how technology can influence and has influenced the task of translation in recent years. First, the Internet with its social media platforms and interlinked databases, along with millions of digitized archival documents from hundreds of languages, have provided the richest and broadest data-set ever for the study of language and translation, spanning not only across dozens of countries but through centuries of cultural artifacts (Bowker and Star, 2000, pp. 292-306; Bowker, 2002; Dash, 2005). Digital humanities scholars are still figuring out how best to explore and extract knowledge from such vast sources, having first to develop the computing power and tools to handle the amount of data alone.

Second, artificial intelligence and machine learning (AIML) have become the de-facto tools to process big data sets, and the translation is not different in that regard (Quah 2006). Tech giants such as Google and Microsoft, and education companies such as Rosetta Stone, Pearson, Duolingo, Babbel, have all been developing AIML-enabled translation engines and similar tools for at least the past decade, with the goal of reaching 'automatic instant translation' as a sort of "holy grail" and utopian ideal not only for real-world tourism and commerce but also for universal, open science for which language is no longer a

barrier. However, there's much debate about the pros and cons of offloading to machines the cognitive skills of language and translation, particularly between those who favor automatic instant translation and those who still favor language learning and all the benefits it brings.

Technology and AIML have also caused advances and controversy in other areas related to language lately. For instance, emojis are hotly contested in the legal world right now as a formal part of speech to be assessed in court (Goldman 2018) – does a winky face emoji constitute sexual harassment in workplace communication or is it just a friendly demeanor? Case law is yet to be settled. Likewise, AIML-enabled facial recognition has facilitated image search analysis for surveillance, cybersecurity, and art-history purposes alike, while proving to have racial biases encoded in the processes and technology, whether by routinely misidentifying black subjects in matters of surveillance, or simply being unable to handle non-white users to the point of locking them out of their own devices because of their skin color (Yapo and Weiss 2018; Introna 2005). Such issues with AIML-enabled facial recognition have prompted researcher Cris Kubli at the University of Texas at Dallas to develop the Emblem project as a complementary feature when AIML translates and interprets speech and movements. This will allow AI facial recognition software to also recognize hand gestures. Hand gestures, widely used to accompany human speech, are notorious “false cognates” because the same body or hand gesture in one culture may have a very different (and potentially offensive) translation in another.

Similarly to written and oral languages, technology has the potential of facilitating translation of disciplinary languages. However, there is no technology for disciplinary language translation. Based on this situation of *translation and technology*, we developed the following preliminary heuristic for transdisciplinary collaboration:

- [Technologies for translation] Use *technology carefully to avoid augmenting misunderstanding caused by systems and algorithms*. Technology can support many areas of collaborative work such as asynchronous communication or documentation; however, there is no technology available that can reliably translate disciplinary languages.

Translation and discomfort

When people experience a context with a different language or discipline, the discomfort becomes a common state. Lukes (2019) argued that our intent to understand a foreign language causes frustration in some situations; however, embracing this emotion can help individuals to make sense and find meanings (pp. 3-4). She uses the metaphor of art interpretation where spectators may be frustrated, but their discomfort helps them make sense of artworks. This also implies they could gain more empathy after embracing discomfort. And empathy is a significant element for collaboration. In transdisciplinary collaboration, individuals can be primed or trained to embrace discomfort to find new meanings and catalyze creativity.

Usually, artists are reluctant to use scientists' methods, engineers rarely aware of creative thinking or methods of

designers, biologists could hardly use the tools of marketing. This silo-oriented thinking could be explained by barriers of knowledge translation between disciplines. If they use methods of foreign disciplines or collaborate with others embracing diverse methods new meanings and greater outcomes could be achieved. For example, when business professionals in collaborations are asked to sketch ideas they are afraid and claim that they are not good at drawing. However, if they are persuaded to embrace the discomfort, and realize that the goal is not to produce a beautiful drawing but to express the ideas, their contributions can enhance transdisciplinary outcomes.

Based on this category of *translation and discomfort*, we developed the following preliminary heuristic for transdisciplinary collaboration:

- [Discomfort] *Persuade collaborators to embrace discomfort and be willing to use methods and tools of other disciplines*. This exchange will enhance transdisciplinary outcomes and creativity.

Knowledge translation

Nowadays, *knowledge translation (KT)* has become one of the most popular concepts in the health field (Davison, 2009, p.77); for example, it is used for diabetes research and treatment (World Health Organization, 2006). KT originated from the linguistic and communication field based on the process of recomposing source material to be intelligible for target audiences (Davison, 2009, p.76). Translation has been conceptualized as an art of bridging the gap between research knowledge and its application in professional practice (World Health Organization, 2006). KT differs from the normal understanding of language translation, which often includes monodirectional processes. Davison (2009) explained that the logic model of KT is a circular or an iterative loop with a multidirectional process among various knowledge translation practitioners (knowledge producers/sources and users/receivers). KT can take place at multiple stages along with translation activities in the knowledge cycle (p.82). Davison also stated that successful knowledge translation depends on the two principles: the level of engagement and interaction of target audiences/stakeholders, and the employment of knowledge to inform decisions that have a positive influence on outcomes. For transdisciplinary collaboration, this indicates collaborators should actively engage and interact more with others in an iterative process and environment, which ultimately helps to generate positive collaboration outcomes.

Further, Liyanage and colleagues (2009) specifically discussed mechanisms of *knowledge transfer* using theories of translation and communication within the general area of *knowledge management*. They explained that the nature of knowledge could be understood mostly in two ways - “tacit and explicit”. Polanyi stated tacit knowledge was intuitive and indescribable knowledge (1962). On the other side, explicit knowledge can be present in formal language and transfer within individuals (Kouloupoulos and Frappaolo, 1999). And the inseparable connection between tacit and explicit knowledge implicates that only individuals with a requisite level of both - shared knowledge - can truly

exchange knowledge (Liyanage et al, 2009, p.120). In another way, according to Alavi and Leidner (2001), knowledge can be understood from a point of view such as “a state of mind, an object, a process, a condition of having access to information, or a capability”. Thus, knowledge management is the ability to manipulate knowledge stored in the brain of individuals to use it, create new knowledge, and help with decision-making in the organizations.

According to Alavi and Leidner (2001), different perspectives of knowledge can lead to different approaches and views of knowledge management. So it is not practical for collaborators to find common grounds for knowledge transferring without figuring out their mutual knowledge perspectives. Further, there is no primary theory of knowledge management. It is hard to have a golden standard for knowledge management because people often understand knowledge in their own way based on their individual experience and background. Good collaboration needs knowledge exchange so it could not happen without connection or understanding of the thoughts, information, goals and process among collaborators. As a general principle there are no ‘best’ methods but many good ones. Therefore, *connection before and during collaboration* is significant for collaborators.

Liyanage and colleagues (2009) understood knowledge transfer in several ways. First, it is an act of communication, which explains the behavioral side of knowledge transfer, i.e. the activity of collaboration between the source and the receiver (p.125). Second, like Davison (2009) stated, knowledge transfer also could be considered as an act of translation, which enlightened how to effectively transform knowledge into a practicable mode. Liyanage and colleagues emphasized that senders of knowledge (source) should transfer knowledge with contextualizing thinking for receivers (users/ stakeholders) (p.124). They considered successful knowledge transfer implies that transfer leads to the target audience to accumulate or absorb new knowledge (p.122). However, they did not discuss what are the factors of successful knowledge transfer. Chauvel and colleagues (2003) suggested that transparency and openness to communicate knowledge and the readiness to learn and absorb it are the main two strategies for organizational knowledge transfer (p.99).

Based on this category of *knowledge translation*, we developed the following preliminary heuristics for transdisciplinary collaboration:

- [Knowledge management] *Engage iteratively in knowledge sharing to use it, create new knowledge, and make decisions.* Collaborators share knowledge continuously during teamwork.
- [Knowledge transfer] *Be transparent to communicate knowledge and be ready to absorb new knowledge.* As transdisciplinarity is expected to produce new outcomes via integrating (not to simply collect) practices, knowledge management should focus on transparency and learning ability to empower teams in creating innovative results.

Transmodal translation and interpretation

An emerging area of translation is between ‘modes’ of human communication such as elaborated by Rainer Schulte and Frank Dufour. They argue in their article “Translation in the Digital Age” (2013) that “We can create objects that contain verbal, visual, musical and sound components that will allow a person to approach the object from various perspectives to create multiple sensory experiences,” for instance the Team Lab speaks of “Within the digital domain, art is able to transcend physical and conceptual boundaries. Digital technology allows art to break free from the frame and go beyond the boundaries that separate one work from another (<https://www.teamlab.art/>). This can be analogized as ‘translation through sentence.’” Thus, digital technology allows us to create a more complex understanding of work and, at the same time, a possibility to establish a continuous interaction with the work”. A specific example of this is translating data into sound rather than into visualization alone.

Artists and designers take advantage of synesthesia to combine sensory information and create potent aesthetic experiences. Some concepts can be more easily understood through sound rather than text or images. And cognitive processing of sound occurs on different time scales than sight, and with different pattern recognition methods. By analogy, this can be compared to the way translation studies differentiates between translation, which focuses on converting written texts between languages or disciplines, and interpretation which focuses on live conversation of spoken word, including aspects such as tone of voice and rhythm of speech.

Finally, as a provocation we raise the issue of trans-species translation. How could one develop methods for translating concepts (emotions, knowledge) between different animal species, or even vegetation, as forms of trans-sentence? This is sometimes referred to as “trans-species psychology” (G.A. Bradshaw, Animal and Society Institute). This would naturally draw on knowledge systems of many indigenous cultures.

Further, this category can be compared to other theories in other fields such as to the ‘six thinking hats’ approach developed by Edward de Bono (2008) or the theory of multiple intelligences of Howard Gardner (2011). Modes of sensing, knowing, learning could include diverse ideas from art, such as spoken word poetry, to academic text, to video abstracts, or even computer code or algorithms. It is asserted that some ideas can be more easily expressed in some modes rather than others.

Based on this category of *transmodal translation and interpretation*, we developed the following preliminary heuristic for transdisciplinary collaboration:

- [Alternative Modes]. *Explore transmodal ways of communication to facilitate understanding and exchange among collaborators.* One way of unpacking some complexities of transdisciplinary work is to utilize a variety of modes of expression.

Disciplines of disciplinary translation

As discussed before, translators exist to transfer meanings between source and receiving audiences. While there is a

need for disciplinary translators to translate and transfer knowledge or methods among disciplines, there could be disciplines of disciplinary translation such as design, education, entrepreneurship, or social work. These disciplines usually have a less stable subject matter of study or their methods could be applied to diverse situations. For instance, in the design field, there has been a discussion about whether design is a category of art or science. Traditional design education originated in art schools. Some independent schools (e.g. Ulm) originated with opposing views and towards more scientific methods of designing, which resulted in valuable outcomes but insufficient for the breadth and nature of design problems. In recent decades, designers have realized that solving wicked problems requires transcending disciplinary boundaries. They have learned to ‘speak’ both the languages of art and science (Mejía et al., 2018, p. 70). Further, Cross (2006) argued that design is a third way of knowing, different from art/humanities and sciences. Nowadays, design often plays the role of a translator to translate theories/knowledge from other disciplines such as psychology, economy and to integrate those theories –knowledge– into the design process. For example, Mejía (forthcoming) stated that behavioral theory could be utilized as a good source for ideation activity in the design process.

Under the circumstance that design is becoming a discipline aimed to develop products, spaces, objects to a discipline able to understand and solve wicked problems in the real-world with interacting and collaborating with others (disciplines, communities, governments, stakeholders, etc.) (Moreno & Villalba, 2018, p. 48). So, designers are then positioned to be translators when artists and scientists collaborate. Furthermore, designers usually design for non-designers, designers could be seen as ‘translators’ between designed products and users to transfer not only aesthetic & functionality but also perceptions & mindset. Gorgoglione (2003) stated two crucial cognitive processes for knowledge transfer: “upstream - *codification* (express knowledge through language, models and images) and the downstream - *interpretation* (understanding the codified knowledge),” which is influenced by the cognitive characteristics of individuals. It challenges translators to choose valid code, encourage people to share knowledge, make knowledge accessible, and translate the coded information accurately (Cranefield & Yoong, 2007). Faced with those challenges, designers as translators should be opened to embrace any possibilities to reinforce their translation capacities. More disciplines of disciplinary translation like design are needed in the future, as well as more disciplinary translators.

Based on this category of *disciplines of disciplinary translation*, we developed the following preliminary heuristic for transdisciplinary collaboration:

- [Translating disciplines] *Bring to the collaboration practitioners from disciplines that can bridge other disciplines.* Disciplines such as design or education theory are used to combine artistic and scientific knowledge. Collaborators from these disciplines can help collaborators deal with the ever uncertain process of transdisciplinary work.

Conclusion

In this paper, we explored the field of translation studies and related areas such as knowledge translation and transmodal sentence. Based on this, we proposed 10 heuristics that can guide transdisciplinary collaboration. Below is the heuristic list for the reference of the reader:

1. [Power relations] *Reduce power dominance between disciplines by equipping collaborators with translation skills and tools.*
2. [Historical situation] *Prepare collaborators to receive insights from other languages and determine the potential disciplinary state or maturity of participants to source or receive discourses.*
3. [Text grids] *Understand the approaches, methods and political implications of every discipline to identify similarities and distinctions in cultures of work.*
4. [Bilingual cognition] *Increase language skills of other disciplines in the collaborators to allow them to produce hybrid outcomes.*
5. [Technologies for translation] *Use technology carefully to avoid augmenting misunderstanding caused by systems and algorithms.*
6. [Discomfort] *Persuade collaborators to embrace discomfort and be willing to use methods and tools of other disciplines.*
7. [Knowledge management] *Engage iteratively in knowledge sharing to use it, create new knowledge, and make decisions.*
8. [Knowledge transfer] *Be transparent to communicate knowledge and be ready to absorb new knowledge.*
9. [Alternative Modes]. *Explore transmodal ways of communication to facilitate understanding and exchange among collaborators.*
10. [Translating disciplines] *Bring to the collaboration practitioners from disciplines that can bridge other disciplines.*

Most of the heuristics show that collaborators should be willing to commit time and effort to develop their skills. However, at least awareness of the needed skills will likely improve transdisciplinary work. Transdisciplinary collaboration is not about addressing the work right away; a good collaboration requires extra work to negotiate and bring rich awareness of every participant. Most of the heuristics presented above are more about preparing the collaborators than recipes for working with others. Success might depend more on how leaders promote an inclusive collaboration than in the sum of expertise of the individual collaborators.

In this paper, we did not develop a final area that merits thought: how to translate results from transdisciplinary collaborations into applications in society. In medicine, the field of translational medicine seeks to do this. Most

academics have little or no political training which is required for the social use of new results; methods of design such as co-design and participatory design are the beginning.

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Authors Biographies

G. Mauricio Mejía is a design educator, practitioner, and researcher. He is an assistant professor of design at Arizona State University. His work focuses on how to design for change and

contemporary design practices such as interaction design, service design, speculative design, and systemic design. Dr. Mejia has published works in visual communication, interaction design, human-computer interaction, transdisciplinary collaboration, and design for change.

Roger F. Malina is an astrophysicist, editor-publisher, and Distinguished Professor of Art and Technology and Professor of Physics at the University of Texas at Dallas. He is the Founding Co-Director of the ArtSciLab, a transdisciplinary research lab focused on hybrid knowledge production, technology, experimental publishing, design, and education.

Yumeng Xie is a PhD student in Design, Environment and the Arts of Arizona State University. She has her Bachelor of Arts and Master of Fine Arts in Environmental Design. Yumeng had interdisciplinary collaborative design work experience in China. Currently, her research interests are transdisciplinarity in design education, collaborative design, team science, participatory design, and sustainability.

Alex García Topete is a writer-filmmaker, entrepreneur, researcher, and McDermott Graduate Fellow in the PhD program of the School of Arts, Technology, and Emerging Communication of the University of Texas at Dallas. His research focuses on transdisciplinary intelligence, knowledge management, and collaboration methodologies, particularly as they relate to the creative industries and their relationship to technology, innovation and knowledge production, social impact, and diverse publics.