Mediating the Sacred: Configuring a Design Space for Religious and Spiritual Tangible Interactive Artifacts

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ABSTRACT

Tangible artifacts and embodied experiences are central to religious and spiritual (R/S) practices, and many HCI researchers and interaction designers highlight the importance of materiality and physicality in design. In this review paper, we bring these perspectives together and examine 44 examples of R/S tangible interactive artifacts (TIAs) from academia, art, industry, and R/S communities to understand their specifics and guide future HCI research and design. We analyze these artifacts and map out a design space for R/S TIAs by matching identified characteristics of R/S TIAs with a framework from the study of material religion. The descriptive and generative R/S TIA Design Space covers insights into bodies, things, places, practices, and backgrounds. This paper offers a novel contribution to HCI research on the value and importance of tangibility and embodiment in technology-mediated practices in R/S contexts and serves as a source for future R/S TIA creation and research.

CCS CONCEPTS

• **Human-centered computing → Interaction design theory, concepts and paradigms**.

KEYWORDS

techno-spirituality, tangible interaction, embodied interaction, review, design space, interaction design, materiality

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1 INTRODUCTION

As people rely more on technology to support aspects of their religious and spiritual (R/S) practices, there is an increasing interest in Human-Computer Interaction (HCI) to design for R/S contexts [9, 11, 93]. This is particularly noticeable in the past three years with initiatives that have brought together HCI researchers, designers, and R/S experts to discuss future avenues for supporting technology-mediated practices of religion and spirituality [81, 82, 103]. However, most of the existing work in HCI for R/S contexts has focused on online or digital technologies and 'techno-spiritual repurposing' [9] whereby 'off-the-shelf' technologies often designed for other purposes, such as office-based work, are appropriated or 're-purposed' to support some aspects of R/S practice. Examples include remote participation in religious events via video-mediated interactions [145], which gained new significance with the COVID-19 pandemic [16, 17, 24, 127, 139, 140]. Recent work in HCI has highlighted the limitations of online and screen-based interactions for R/S contexts [24] and explored alternative avenues, including the design of tangible interactive artifacts (TIAs) for creating meaningful techno-spiritual connections [138], but this work is more the exception than the rule. This lack of attention in HCI to the centrality of the tangible, embodied, and interactive dimensions of R/S practices is unfortunate and fundamentally disregards that R/S practitioners across time, traditions, and contexts have created and utilized tangible artifacts for R/S purposes, a fact that is highlighted by the work done by scholars in the field of material religion [19, 64, 92]. Given the existence of various, scattered contemporary examples of TIAs for R/S practices and knowledge on the material aspects of interaction, we sought to bring together, structure, and analyze this body of work in light of relevant literature (i.e., tangible interaction, techno-spirituality, and material religion) to understand the qualities of these TIAs, define a design space for R/S contexts, and articulate reflections and considerations for future research and design.

In our paper, we present insights from our review of 44 R/S TIAs and frame a design space with novel and under-explored areas for

interaction designers and HCI researchers within the Tangible, Embedded and Embodied Interaction (TEI) community to investigate. We understand this design space as a form of intermediate-level knowledge [33, 52] offering both descriptive knowledge about the body of existing works and generative knowledge inspiring novel research and design. The design space presented is, therefore, our answer to the following research questions (RQs): (i) What are the qualities of TIAs designed for R/S practice? (descriptive), (ii) what R/S practices do they support and how? (descriptive), and (iii) what is the potential of tangible interaction for interactive design in R/S contexts (generative)? In order to investigate these questions, we have adopted a framework from the study of material religion that focuses "one's attention on the evidence and insights offered by bodies, things, places, and practices" [86, p. 209]. This framework allows us to identify the qualities of TIAs and categorize their features, uses, etc.

This paper is structured as follows. In the section Related Work, we make explicit our understandings of R/S contexts and TIAs and introduce relevant literature on tangible interaction, techno-spirituality, and material religion. We then describe our procedure of identifying, reviewing, and analyzing relevant artifacts in the section Methodology, supplemented by a positionality statement and a short description of the final artifact corpus. In the section The R/S TIA Design Space, we map out the novel design space for R/S TIAs based on our analysis of the artifact corpus. The section Discussion reflects on emerging themes, such as representation, the "how" of design in R/S contexts (e.g., "practice through design"), spiritual informatics, and breaking boundaries, which all provide inspiration for future research and design. We also discuss the limitations of our work and conclude by re-emphasizing the importance of tangibility and embodiment in technology-mediated practices for R/S contexts.

2 RELATED WORK

2.1 Designing for Tangible Interaction

Early work on Tangible User Interfaces [32, 51, 123] focuses on giving physical form to digital information [123] through interactive couplings of physical artifacts with computationally-mediated digital information [51, 53]. This work takes Graphical User Interfaces towards Graspable User Interfaces [59] through direct manipulation of digitally-augmented artifacts. Usability testing conducted at this time shows the qualities afforded by tangible user interfaces for user experience in contrast to more standard desktop interfaces like the mouse or keyboard [129]. Indeed, Klemmer and Takayama [67] criticize the "desktop computing paradigm" which has reduced our physical performance significantly, therefore limiting the rich actions our bodies are capable of. They draw from theories of embodiment and describe five themes to explore the body as a resource for richer interaction paradigms. At a similar time, Hornecker and Buur [53] define tangible interaction – a concept that goes beyond Tangible User Interfaces - and suggest a framework that unpacks the qualities and potential of tangible interaction for experiential design. They draw from art and design practices to highlight experiences that afford spatial interaction that is emplaced and embodied. Here the focus is on designing beyond form and appearance for bodily interaction with artifacts [32, 53, 67]. To guide our work and understanding, we use Hornecker and Buur's definition that tangible interaction "encompasses a broad range of systems and interfaces relying on embodied interaction, tangible manipulation and physical representation (of data), embeddedness in real space and digitally augmenting physical spaces" [53, p. 437]. Indeed, their framework provides us with conceptual guidance for assessing TIAs; particularly with regard to describing material engagement and affordances of tangible manipulation. We also take inspiration from the work of Döring [31], who describes a material-centered approach for interaction designers to assess how material aspects may affect technology-mediated experiences. To support this, Döring outlines two perspectives: a micro perspective, which focuses on material and technical aspects, and a macro perspective, which is concerned with contexts for application (i.e., the different meanings of materials in different cultural and historical contexts) [31].

In this paper we are sensitive to a variety of approaches to the design of TIAs. For instance, a design-oriented research approach for tangible interaction shows the importance of an iterative process, which encourages learning by prototyping and testing with real users [129]. Also critical is to conduct longitudinal studies to assess the real impact of tangible interaction whereby research and knowledge gained from the field can be integrated through design into "relevant, highly experiential prototypes" [129, p. 114]. A recent example of this is the long-term deployment of soma design prototypes in households [113], which documents alternative ways of being in the world and "transformative becomings" [p. 12] towards leading richer lives. Additionally, engaging with materials and learning through making are critical to Research through Design (RtD), an approach used in HCI to deal with "wicked problems" [10] and transform the world from its current state to a preferred state [146]. Artifacts resulting from RtD "become design exemplars, providing an appropriate conduit for research findings to easily transfer to the HCI research and practice communities" [146, p. 463]. Indeed, knowledge generated from these artifacts can in turn inform theory, which is "provisional, contingent and aspirational" [38, p.943]. The value of participatory design [108] and co-creation [107] was also highlighted in recent HCI research [82, 138] to collectively explore, express, and test future scenarios for R/S contexts. In order to account for this diversity of approaches, we have documented aspects of the design process for TIAs included in our review and recognize the value of participatory and design-led approaches for exploring R/S contexts and possibilities.

2.2 Techno-Spirituality

Techno-spiritual practices [9] are characterized by the use of information and communications technology in R/S practices and experiences. In the past 20 years, there has been an increasing interest in HCI in designing for spirituality [9, 12, 93] but, arguably, there remains a dearth of research in this space [11]. From their literature review, Buie and Blythe [12] observe that technology can support religious individuals or groups on three different levels; first, on an institutional level (e.g., through mediating religious communications and fostering pastoral care [145]); second, on a practical level (e.g., through the utilization of interactive technologies to support Sabbath day observance among Orthodox Jewish families [141]),

and finally, on an experiential level (e.g., by using tangible interactive technologies to provide an immediate spiritual experience that is multi-sensory and immersive [46]). Frameworks such as these are helpful for those working in this space, and while research so far has been encouraged in the exploration of experiential designs [12], there has yet to be a sustained attempt to broadly consider the tangible, physical, and embodied dimensions of techno-spirituality.

To date, mobile applications have played a central role in the research of techno-spiritual practices [12, 14, 28]. Research outside of HCI has documented the increasing use of mobile phones for religious purposes [13], including research on religious texting services [104], which shows the need to re-think these services to cater to the interpersonal needs of people, especially young people. Others have conducted reviews evidencing the proliferation of mobile apps for R/S purposes while spotlighting key app functionalities to support R/S practices [14, 133]. Most recently, research on mobile health has evidenced a missed opportunity for HCI to consider religion and spirituality in the development of supportive tools for health and wellbeing [112]. However, missing from these research approaches are considerations of the value and importance of tangibility, materiality, and embodiment as key dimensions of the R/S practices.

This absence of consideration for the physical also extends to a large body of HCI works, which so far has predominantly focused on virtual and screen-based interactions with a trend for "techno-spiritual re-purposing" [9]. While it is not a new practice to connect online to access spiritual content or to participate in faith-related activities, the COVID-19 pandemic accelerated the trend of such mediated interaction, providing R/S communities with new ways of congregating and practicing online. For example, recent research [36] documents how churches swiftly moved to a new online presence for congregations while showing how current online systems (i.e., streaming platforms) do not account for the needs of R/S practitioners [139]. Another example is the case reported by Claisse and Durrant [24], where members of a Buddhist community adopted the video-conferencing platform Zoom to chant with one another remotely. They highlight the limitations of re-purposed tools that were designed for other purposes and were not aligned with the needs of the Buddhist community. In short, these new forms of techno-spiritual practices present new challenges and implications for R/S communities with risks of deeply changing and altering the essence of R/S practices [24, 30, 139, 140]. Indeed, it has been emphasized that online mediated interactions cannot replace analog ones, such as meeting in person, experiencing community, and performing rituals deemed essential to R/S practice [24, 139, 140, 142]. Unfortunately, current uptake and use patterns in R/S communities tends to be technology-led, fostering a disconnected view that does not acknowledge broader ecologies of spiritual practices, their relational aspects, and their situatedness [3]. Therefore, we see an opportunity for interaction designers and HCI researchers with an inclination toward tangible interaction to highlight and explore alternative designs that are more experiential and embodied and are tailored to the needs of R/S communities, a move that will help supplement current approaches to techno-spirituality.

2.3 Material Religion

The field of material religion seeks, in essence, to draw attention to the fact that religion is more than just belief and that understanding religion as only a matter of belief is a fundamental misunderstanding of what religion is or how it is performed in the world [91, 96] (see also [4, 84, 96] on the inherent Western, and specifically Protestant Christian, bias implicit in belief-centered conceptualizations of religion). More explicitly, material religion draws attention to the centrality of embodiment and tangibility in religious practices, with Morgan defining "the material culture of lived religion in terms of several categories of practice that put images and objects to work as ways of engaging the human body in the configuration of the sacred" [90]. For this paper, we adopt Lincoln's conceptualization of religion as being made up of four domains which include *a discourse*, *a set of practices*, *a community*; and *an institution* [72, p. 5-7] (also cited in [110]), which aligns with perspectives in material religion. However, we also seek to consider and account for spirituality (which may or may not be religious) and adopt Puchalski et al.'s definition of spirituality as "the aspect of humanity that refers to the way individuals seek and express meaning and purpose, and the way they experience their connectedness to the moment, to self, to others, to nature, and to the significant or sacred" [101, p. 887] which is similarly congenial to material approaches. Indeed, we argue that given large-scale societal changes, including the growth of those who identify as "spiritual but not religious" [98] and New/New Age Spirituality [44, 114], it is necessary to consider spirituality in tandem with religion, and that material religion is an equally useful lens through which to understand the material and embodied aspects of spirituality.

The attention in material religion to concerns that align with those of tangible and embodied interaction is demonstrated in a 2011 special issue of the journal *Material Religion* on the "key words in material religion," which included articles on body [147], medium [85], movement [97], ritual [40], sensation [54] (see also the edited volume *Sensational Religion: Sensory Cultures in Material Practice* [100]), sound [134], space[122], taste [37], thing [88], and touch [29], each of which foregrounds the centrality of the tangible and embodied nature of religious practice and religious life. Indeed, what we perform in this review is aligned with the practice in material religion of material analysis [89], which "may be said to focus on the object, its physical setting, or practices involving the object" [86, p. 209]. In fact, Morgan proposes "nine aspects or moments" of material analysis, which include medium, design, manufacture, function, comparison, remediation, deployment, reception, and ideology or cultural work, [89], each of which is addressed in some way during our review of the artifacts. And while a material religion approach would also draw attention to the materiality (and material culture) implicit in online or digital-only R/S tools or communities, our specific focus is on those artifacts and practices that are more fully embodied and emplaced. As such, the study of material religion seems to be a natural ally to tangible interaction research dealing with R/S contexts as well as a rich resource to draw from for the examination of R/S TIAs.

It is for this reason that we chose to adopt a framework from material religion to configure our R/S TIA Design Space based upon a statement by Meyer et al. which reads, "What then does it mean

to study the material culture of religion? It means to focus one's investigation on the evidence and insights offered by bodies, things, places, and practices" [86, p.209]. In this review and the construction of the design space, however, we seek not only to engage in the description and analysis of the R/S TIAs but, more importantly, to put forward the design space as a generative tool to help guide designers and HCI researchers in the creation of future R/S TIAs. This movement toward the generative possibilities of the framework not only expands past the generally descriptive or analytical focus of material religion, thus providing new insights that might enrich that field by offering novel artifacts (and potentially practices) for consideration, but also aligns with a possible "fifth wave" [74] in the field of digital religion that would move past the description and analysis of "how religious individuals and groups engage with digital media and emerging technologies" [15, p. 1] to the explicit development of novel technologies, a movement in digital religion that could be grounded in the design space we articulate in this paper. The work in this paper, then, stands as a novel and important contribution not only to HCI but also to at least two subfields in religious studies: material religion and digital religion.

3 METHODOLOGY

3.1 Researcher Positionality

We first provide a brief description of our background, identity, and beliefs to support transparency and help contextualize our research inquiry. The authors have been working together for the past year as part of the Spirituality, Religion, and Interactive Technology Design (SPIRITED) Collective (spiritedhci.org) which was established in 2022 following a workshop [82] aimed at fostering interdisciplinary collaborations between researchers, professionals, and R/S experts. Since then, we have published a zine that summarizes the output from that workshop [83], have organized an additional workshop in 2023 [79], and have continued to expand the membership of the Collective to include others who work, or are interested, in this research and design space.

Robert B. Markum is an HCI researcher who has examined the intersection of interactive technologies, meditative/contemplative practices, and transcendent experiences [80]. He was raised in a Christian tradition (The Church of Jesus Christ of Latter-day Saints) and currently self-identifies as "spiritual but not religious" with an inclination toward what Bron Taylor has called "Gaian Naturalism" [118].

Sara Wolf is an HCI researcher/designer who came across the R/S context through her research on rituals and interactive technologies. She is currently working with Protestant theologians to explore novel technology-mediated religious rituals [e.g., 138, 140]. She was raised in a Christian tradition (Roman Catholic) but left church in her twenties.

Caroline Claisse is a design researcher who has experience in designing for tangible interaction in cultural heritage settings [26]. She recently developed a research interest in R/S contexts using her own experience as a member of a Buddhist community [24], which she joined in 2018.

Michael Hoefer is a cognitive and computer science researcher working on designing personal informatics systems to support personal and community development. His recent work has focused on how lifestyles align with fundamental human needs and values [49] and how *faith informatics* could be used for spiritual development [50]. Michael is part of the Catholic Church.

The author team is, therefore, composed of individuals who have design research expertise with a strong interest in tangible interaction, which influenced the focus and approach for our review. Because of our research interests and previous work, we were also already familiar with most of the design artifacts included in our review.

3.2 Identification of R/S TIAs for the Corpus

Our aim with this review of TIAs is to inspire and enrich designers' and researchers' understanding of how TIA's can draw from R/S contexts or support R/S practice. Throughout this paper, we use the term "artifact" to designate these technologies, similar to what others have done [e.g., 43, 111] and, additionally, to distinguish them from objects. By this distinction, we take objects to be naturally occurring (e.g., a rock, a tree, etc.) while artifacts represent things that have been made or crafted [121]. In the case of R/S, this distinction helps to highlight the difference between sacred objects, which are not made by human hands but may have sacred qualities or meanings attached to them (e.g., trees), and artifacts, which human hands have crafted for R/S purposes. In the next sections, we use "artifacts" instead of TIAs in some places to improve readability.

Conceptually, we build on previous works (e.g. [111]) that take a design-oriented approach to review works, which can be described as non-exhaustive, qualitative, and generative. Thus, we do not claim to review every single work related to R/S, but instead, we have compiled a corpus of artifacts that helps us frame a design space for future work focused on technology-mediated interaction that supports the tangible, embodied, and multi-sensory aspects of R/S practice. The corpus of artifacts includes interactive systems, prototypes, installations, and commercialized products that were purposefully designed for a particular R/S context or community (or that use/leverage symbols and understandings from a specific R/S context or community) and that included digital as well as material aspects. To identify relevant artifacts for our corpus, we used three main methods: first, we performed a systematic search in the ACM Digital Library Database; second, we augmented our corpus with relevant artifacts known by the research team; and third, we drew from our most recent workshop on "Designing Tangible Interactive Artifacts for Religious and Spiritual Purposes" [81].

We first searched the ACM Digital Library Database (ACM Full-Text collection) using the following keywords: "spirituality" OR "religion" OR "religious" OR "spiritual" OR "ritual*", yielding 529 results. We restricted our search to 'Abstract only' as we wanted to capture work that specifically focused on R/S contexts (i.e., instead of papers citing related R/S work in the background review). We then reviewed all 529 abstracts using our inclusion and exclusion criteria. For papers to be included in our corpus, we listed the following requirements:

- To feature a design artifact (e.g., interactive systems, prototypes, products, or artworks). Papers without an actual design output (e.g., only featuring speculative proposals or

concepts sketches with no extended description or elaboration) were excluded;
- For the artifact to feature some form of tangible interaction (as defined by Hornecker and Burr [53]). We included artifacts that enabled hybrid forms of interaction (e.g., digitally-augmented artifacts) and excluded work that solely focused on online and digital technologies (e.g., online communities, mobile applications). We also excluded works that exclusively focused on Virtual Reality (VR) and Augmented Reality (AR) as we wanted to keep focus on real-world and material aspects;
- For the artifact to be bespoke to the R/S context and support some aspects of R/S practice or to integrate symbols or elements from a specific R/S context or community. Works that focused on the re-appropriation of usual technologies to serve R/S were excluded.

Based on our inclusion criteria, only 12 papers from the database search were included in our corpus. We acknowledge that this is a relatively small number, which in itself shows the limitation of existing work in this space in HCI. During our review process, we excluded a large number of papers reporting on the design or use of mobile applications and online platforms [e.g., 139, 143]. Papers that featured some interactive tangible artifacts but that did not explicitly connect to R/S practices were also excluded [e.g., 65, 68]. We then added more artifacts to our corpus by including relevant papers listed in the cited work of our initial 12 included papers. Each team member also contributed additional examples based on their knowledge from their previous work in the R/S context and conducted additional online searches (e.g., for commercial products and artworks). Integrating products from outside academia was inspired by previous work that demonstrated how, for example, commercial products covered a broader range of R/S purposes than the current literature [e.g., 12, 14], so in order to base our analysis on as broad a range of different examples as possible, we specifically searched for academic and non-academic examples. Finally, we asked for and received permission to include eight additional TIAs contributed by participants to our recent workshop on the design of R/S TIAs [81].

In total, we considered 70 artifacts for inclusion in our corpus and evaluated them using our inclusion and exclusion criteria during two collective round-tables. We ultimately excluded 26 artifacts for various reasons. For instance, we excluded the Spiritual Power Battery [2] used by the Aetherius Society in its Operation Prayer Power meetings because the battery is not an actual functioning technological artifact but rather a symbolic artifact, the Zenscape [63] artifact which is inspired by Zen gardens but is oriented exclusively towards the practice of taking microbreaks rather than any R/S oriented purpose, and a funeral webcasting system in Japan reported by Uriu [127] given that it re-purposed an existing system (e.g., Zoom). Overall, this process resulted in a final corpus with 44 artifacts.

3.3 The R/S TIA Corpus

The final corpus consists of a total of 44 artifacts (see Appendix Table 1 for an overview), including 34 artifacts from academic sources [18, 20, 22, 27, 35, 39, 45–48, 55, 60, 66, 69, 73, 76, 77, 79, 105, 116, 119, 120, 124–126, 131, 138, 140] and ten artifacts from non-academic sources [1, 7, 23, 34, 58, 94, 99, 102, 115, 135]. Three academic sources contained multiple artifacts which were included in our corpus: Hemmert et al. [45] (four artifacts), Chu et al. [22] (3 artifacts), and Chatting et al. [18] (3 artifacts). The majority of academic artifacts were sourced from papers published in conferences, with the top three being ACM venues: DIS (11 papers), CHI (6 papers), and TEI (4 papers). Most of the works published were Extended Abstracts and Demo papers with only twelve full papers. The two oldest artifacts are from the 1950s [23] and 2002 [46]; all other examples were published after 2008.

The majority of artifacts included in our corpus were design prototypes, of which 30 were functional and seven non-functional prototypes. Among the 30 functional prototypes, seven were explicitly presented as artworks [1, 34, 35, 73, 76, 77, 102]. The rest of the corpus included three artifacts developed by a R/S community and used in that specific community (e.g., The E-Meter [23]) and four commercial products (e.g., eRosary [99]), that is, artifacts that were developed and commercialized at scale for profit and for use by the wider public.

For most artifacts, we could not find any documented evaluation (25 artifacts). We note that the artifacts may have been evaluated, and it just was not publicly documented. Two artifacts were evaluated by third parties, meaning that others than the creators of the artifacts evaluated them. For example, BlessU-2 was designed as an experimental art piece by the Protestant Church in Hesse and Nassau in Germany [34] but evaluated by an interdisciplinary team of Protestant theologians and HCI researchers [74, 75]. Fifteen artifacts were evaluated through various forms of user testing (e.g., [77, 105]), ranging from open-ended explorations and think-aloud to interviews to comparative studies. Four artifacts were deployed in the field for evaluation purposes (e.g., [39]). Only one paper explicitly formulated ethical considerations in relation to the artifact's appropriateness [119].

3.4 Corpus Analysis

Guided by our (design-driven) motivations and research questions, we conceptualized rough categories to be coded when reviewing the corpus, such as the artifact's purpose and functionality. The emerging categories were also inspired by similar work on data physicalization [8] and relevant theoretical-oriented literature, such as a materials perspective [31]. The initial categories were then refined during discussion and after thoroughly reviewing a small sample of artifacts featured in our corpus. To support review and analysis, we created a template on Miro based on our discussions of initial codes with four broad categories: general information, context, interaction, and design process. Each team member then used the template to document a selection of the corpus artifacts.

During the coding process, we met at regular intervals to compare our documentation methods and develop a common understanding of the codes and the corpus. Once all the artifacts were documented, we clustered the entries of each category to identify recurring elements. During this process, we recognized the entries could be restructured in a way that mapped onto the four aspects of material religion (i.e., bodies, things, places, and practices) mentioned above [86]. Restructuring our entries according

to the framework supported us in elaborating on commonalities and differences across the corpus. Again, this was an iterative and discursive process that took place not only through recurring meetings but also asynchronously (e.g., via comment functions). In order to record the results of this process, we developed an overview table in which all contributions are listed with their characteristics in the various categories and subcategories[1]. Through analyzing, categorizing, and documenting all artifacts within the framework of material religion, we identified overarching themes and salient features that correspond to our RQs and informed the creation of the design space for R/S TIAs.

4 THE R/S TIA DESIGN SPACE

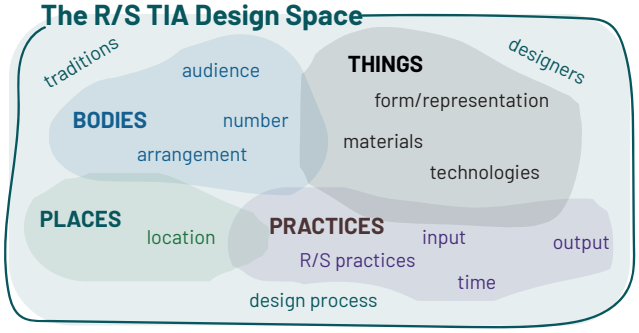

Figure 1: The R/S TIA Design Space.

To analyze our corpus, we have drawn from literature on material religion, which highlights four key aspects for investigating the material dimension of R/S practice: *bodies*, *things*, *places*, and *practices* [86]. We have used these as the foundation for structuring our analysis and developing the R/S TIA Design Space, which is presented in Figure 1. Next, we provide a brief description of the main categories of the framework. The four sections corresponding to the key aspects are introduced with a quote from the source document [86] as a gentle provocation while supporting sense-making of the categories featured in the R/S TIA Design Space. A complete description of the categories, subcategories, and codes is provided in the supplemental materials. In some cases, the same artifact may appear multiple times in any given category (e.g., Input), and not all variations of artifacts for a subcategory (e.g., sound) may be reported due to space constraints. Further, the number of artifacts mentioned for a subcategory (e.g., 6/44) may not always match the number of listed references due to the fact that, as mentioned above, some papers included multiple artifacts (e.g., [45]). For each of the four dimensions, we have also incorporated an illustrated example to demonstrate how *bodies*, *things*, *places*, and *practices* play out in different artifacts (see figures 4, 6, 8, 10).

First, we address the *background* (Figure 2) which documents the broader context in which TIAs are created. Then, the *bodies* section (Figure 3) identifies the intended users and captures information about user engagement with the TIAs; the *things* section (Figure 5) describes the qualities of the artifact with particular focus on form/representation, material, and technological aspects; the *places* section (Figure 7) identifies the type of location where engagement with TIAs takes place; and finally, the *practices* section (Figure 9) is concerned with describing the temporal and experiential qualities of the action mediated by the TIAs. The visual forms of the R/S TIA Design Space and its subcomponents reflect our view that this design space is in-formation (rather than tightly-bound and firmly determined) and stand as an invitation to others to explore and add to this space.

4.1 Background

Figure 2: The background category of the R/S TIA Design Space in detail.

4.1.1 Traditions. The 44 artifacts represent a variety of R/S traditions, although two R/S traditions (*Christianity*, 20 artifacts; and *Buddhism*, ten artifacts) account for the vast majority of the artifacts in the corpus (30/44). Within Christianity, ten artifacts come from Catholicism [1, 35, 39, 45, 47, 99, 119], six from Protestantism [27, 34, 55, 115, 138, 140], one from the Church of Jesus Christ of Latter-day Saints [60], and three had no explicit connection to a specific Christian sect [22]. For Buddhism, three artifacts come from the Soka Gakkai tradition [18], two from the Tibetan tradition [76, 77], one from the Chinese/Han tradition [135], and one from the Vipassana tradition [48], while three don't explicitly refer to a specific Buddhist tradition or school [124–126].

Islam [7, 58, 94] and *mindfulness* [73, 105, 131] each account for three of the 44 artifacts, with the other R/S traditions (*Scientology* [23], *Unitarian Universalist* [46], *Judaism* [66], *BuKongo* [102], and *Vodou* [20]) only represented by one artifact each. Finally, three of the artifacts were specifically designed with attention to *multiple R/S traditions* (Christianity and Buddhism [79], Taoism and Buddhism [120], and multiple spiritual/mystical traditions [116]).

4.1.2 Designers. The 44 artifacts in our corpus were designed by, or were the result of collaboration between, individuals from several different contexts, including *religious communities*, *industry*, *academia*, *museums*, and *art*. The vast majority of the artifacts (25/44) were the sole product of designers within academia [18, 20, 35, 45–48, 60, 66, 73, 76, 77, 79, 105, 116, 119, 124–126, 131]. Three of 44 artifacts were solely designed by practitioners or leaders in a specific religious community [23, 34, 115], three by individuals in a commercial or industrial context [7, 58, 94], one by an individual working in a museum [102], and one by an artist [1]. The remainder of the artifacts were the product of some kind of *collaboration between individuals from different contexts*, including five artifacts from a religious/academic collaboration [27, 39, 55, 138, 140], three

[1]The corpus is available online at https://spiritedhci.org/rs-tia-database/

artifacts from a museum/academic collaboration [22], one artifact from a religious/commercial collaboration [99], and two artifacts from a religious/commercial/academic collaboration [120, 135].

4.1.3 Design Process. 12 of the 44 artifacts were either explicitly stated as, or implicitly recognizable as, being the result of an *iterative* design process [22, 66, 73, 105, 119, 124–126, 131, 140], with some artifacts, such as the SenseVase [124], involving iterations after expert interviews. Several of the artifacts (10/44) were labeled as *speculative* designs, which resulted in functional prototypes [20, 45], non-functional prototypes [45, 79], or design descriptions [47, 48, 60, 116]. A smaller subset of the artifacts (7/44) were explicitly involved in a *co-design* process that included individuals from different specific religious contexts during the design process [27, 39, 55, 120, 135, 138] (e.g., the Prayer Companion, which was the result of a co-design process that included an academic team and the nuns at the St. Johns Convent of Poor Clares [39]). Among the artifacts from academic contexts, seven explicitly approached the design process from a *research through design* perspective [18, 35, 39, 131, 138], with several, such as the Voice, the Bell, and the Beads [18] and Transient Relics [35], utilizing the artifact as a means to investigate materiality and/or sound as a design material. In some cases (11/44), there was no description of the design process or design orientation explicitly (or implicitly) communicated in the academic paper where the artifact appears [46, 76, 77] or the specific design process is *unclear* given the artifact's status as a commercial [7, 58, 94, 99], artistic [1], museum [102], or religious community-specific artifact [23, 115].

4.2 Bodies

> A *body* consists of viscera, skeleton, musculature, and flesh, but also brain/mind, sensation, imagination, cognition, and the interface with the worlds around and within the body...And bodies are the medium of social experience, the gateway to the social bodies to which individuals belong, with which they identify, through which they feel and perceive themselves, others, and the divine. [86, p. 209]

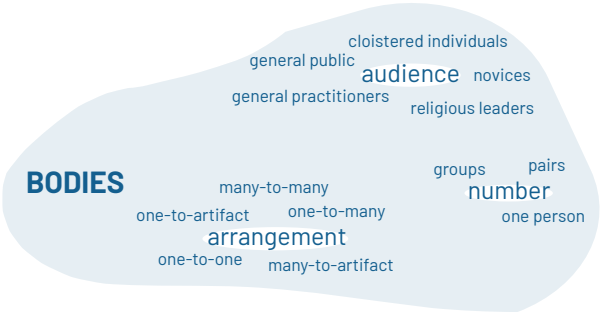

Figure 3: The bodies category of the R/S TIA Design Space in detail.

4.2.1 Audience. The intended audience of the artifacts can be generally divided into *general public* and *practitioners* of a specific R/S tradition. In some cases (11/44), the artifacts were targeted at or intended for use by the *general public* [20, 22, 35, 76, 102, 115, 116, 125, 127]. For example, the Bönewebben (Prayer Web), created by the Church of Sweden, was targeted at anyone who would like to participate in the Allhelgona (All Hallow's Day) festival [115], and the Visual Voyage, Experiencing Spirituality, and Scents of Power prayer nuts were intended to be experienced by museum visitors [22], although users may have very different experiences based upon their relationship with the R/S tradition that serves as the origin for the artifact/practice.

In terms of artifacts intended for use by religious practitioners, we further broke down that category into four subcategories: *general practitioners*, *religious leaders*, *cloistered individuals* (e.g., nuns, monks), and *novices*. 14 of the 44 artifacts were intended for general practitioners of a specific R/S tradition [7, 18, 46–48, 58, 66, 77, 99, 119, 120, 138], such as the iQibla Zikr Ring, which can be used by any practicing Muslim for their daily prayers [58], or the Interactive Temple, which can be experienced by any practitioner who goes to the Hu-Ann Temple where the artifact was installed [120]. One artifact was explicitly intended just for cloistered individuals, the Prayer Companion for the Sisters of Poor Clares [39], while two artifacts were explicitly intended for novices of a particular R/S tradition: the Reminder, which is intended for youth of the Church of Jesus Christ of Latter-day Saints [60], and My Salah Mat, which is intended to instruct children or reverts in Islamic prayers [94]. Several of the artifacts (5/44), instead, were intended for use by a variety of individuals of different types within a specific R/S community [23, 27, 55, 105, 140], such as the E-Meter in the Church of Scientology, which is intended to be used by a religious leader and a novice during an auditing session [23] or the God-I-Box, which is intended to be used by general practitioners and/or religious leaders in workshop settings as a discussion starter for what the future of technology-mediated worship services might look like [140].

Finally, 11/44 artifacts were intended for either a general audience or practitioners from a specific R/S tradition [1, 34, 45, 77, 79, 126, 131, 135]. For instance, the Sonic Cradle was intended for use by both novices in mindfulness practices or those who had never done them before [131], while the Desire Box, which drew upon both Christian and Buddhist traditions in its design, was intended for use by practitioners in those traditions as well as anyone who might be seeking to address unhealthy attachments [79].

4.2.2 Number. More than half of the artifacts in the corpus (26/44) were designed to be used by only *one person* at a time [1, 7, 20, 22, 27, 34, 45, 47, 48, 55, 58, 60, 73, 77, 79, 94, 99, 102, 105, 116, 119, 120, 131, 138]. This is the case for many artifacts given that the associated practice is done alone, such as praying with the eRosary [99], engaging in mindful reflection with Mind Pool [73], relieving oneself of worries with the Font of Solace [55], or practicing silence with the Necklace of Silence [47], or that there is only one of the artifact that can be interacted with by a single person at a given time (e.g., Technkisi [102]). Only six artifacts are explicitly intended to be used by a *group* [18, 46, 76, 115], including the Bell, the Voice, and the Beads [18], which are used by a group while collaboratively engaging in daily practice. Seven of the 44 artifacts support either *individual or group interactions* [35, 39, 124–126, 135, 140] where the artifact is not explicitly tied to the practice of a single individual

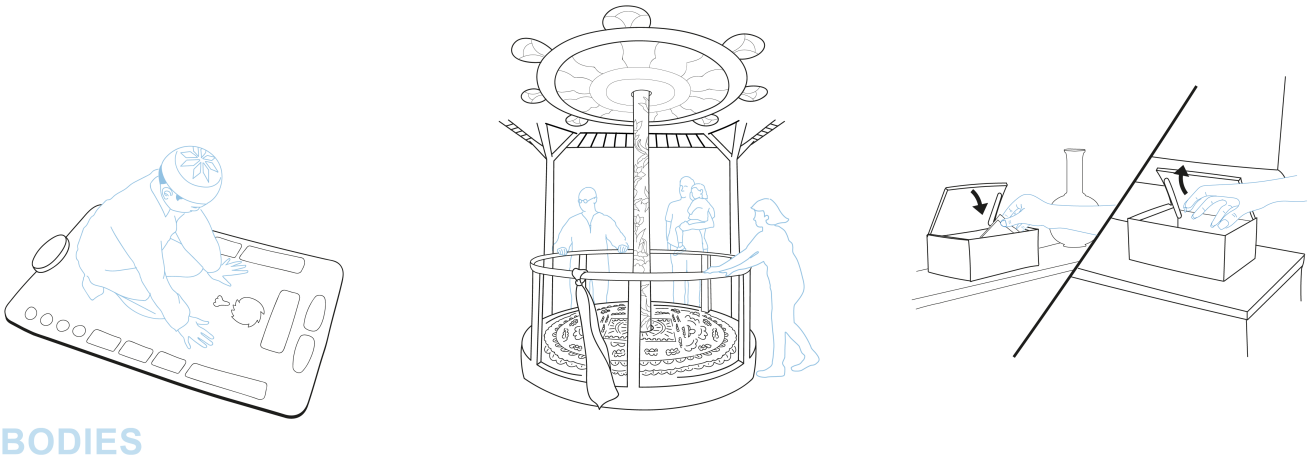

Figure 4: The illustrations show how the *bodies* category is represented in three R/S TIAs, each targeting distinct audiences, numbers, and arrangements, i.e., a novice practitioner interacting with the artifact (My Salah Mat [94]), members of the general public collaboratively interacting with the artifact (Wish Happiness [76]), and a pair of users with the artifact meditating their interaction (Chests of Mindfulness [45]). Illustrations by Wolf and Claisse.

(e.g., the ThanatoFenestra could be used by an individual or an entire family simultaneously [126]). There is also a small number of artifacts (5/44) that are explicitly designed to be used in *pairs* (or in pairs of groups) [23, 45, 66], such as the Balance of Equality, which requires two individuals to make it function [45], and the Robotic Menorah, which requires two pairs of groups (or, theoretically, two individuals) that each have one of the connected devices to engage in the practice of lighting the candles [66].

4.2.3 Arrangement. The majority of the artifacts (23/44) in the corpus support a *one-to-artifact* arrangement [1, 7, 20, 22, 34, 47, 48, 58, 60, 73, 77, 79, 94, 99, 102, 105, 116, 119, 120, 131, 138], meaning that the artifact plays no mediating role between two or more individuals, and the interaction is solely with the artifact (i.e., there is no other person "on the other side" of the interaction). This is the case with the Digital Tasbih Counter [7], where the individual is just using it to count the number of prayers, and with Inner Garden [105], where one individual is just interacting with the mixed reality sandbox. In comparison, three artifacts support *one-to-one* arrangements [23, 45], such as the E-Meter, which mediates the interaction between the auditor and auditee [23], and the Light of Connectedness [45], where two oil lamps mediate the interaction between two individuals at a distance. There is one artifact (the SenseVase [127]) that is framed around a *one-to-many* arrangement, while there are five artifacts [18, 35, 76] that implicate a *many-to-artifact* arrangement where all the individuals are working together toward the artifact, such as Wish Happiness [76] where the individuals are all pushing the merry-go-round together. In this case, the artifact is the "target" of the action rather than a mediator between a group of individuals.

The remainder of the artifacts support multiple co-incidental arrangements of bodies and artifact, with five artifacts supporting a one-to-artifact and a many-to-artifact arrangement [39, 125, 126, 135, 140] where one or multiple people can simultaneously be interacting with the artifact in a situation where the artifact isn't mediating their interaction (e.g., the God-I-Box [140], where one or more people can be using it simultaneously). Two artifacts [27, 55] support either a one-to-artifact or one-to-many arrangement, where the practice is simultaneously an individual action for oneself that also leads to interaction with others (e.g., the Font of Solace [55] where one person writes their worries in the font but then the worry is 'broadcast' to the congregation), while the Chests of Mindfulness [45] mediate an interaction between two users (one-to-one) within a network of many possibly users (one-to-many). Two artifacts support a one-to-many and *many-to-many* arrangement [45, 46], such as the AltarNation [46] where each practicing individual is engaged with multiple people (and all are multiply engaged with multiple others), and one supports one-to-one, one-to-many, and many-to-many interactions: the Robotic Menorah [66] that entails interactions via the artifact but does not dictate how many people would or could be on either side of the interaction. Finally, the Bönewebben (Prayer Web) [115] was arranged around simultaneous one-to-artifact, one-to-many, many-to-artifact, and many-to-many arrangements when it was implemented for the Allhelgona (All Hallow's Day) festival in 2014 and 2015 [56].

4.3 Things

> *Things* are the objects of the body's apprehension, but they are also agencies within themselves, either as other bodies, or as the extension or completion of a body, or as the presence or symbol of a social body. Things are exchanged and circulate bearing values and powers that structure human relations. [86, p. 209]

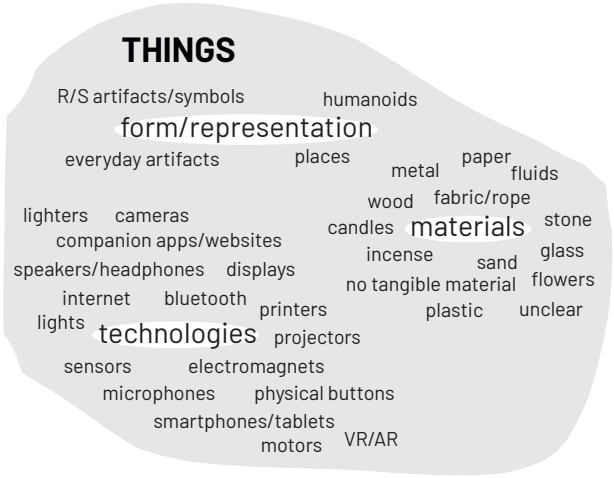

Figure 5: The things category of the R/S TIA Design Space in detail.

4.3.1 Form/Representation. A majority of the artifacts (24/44) took inspiration from existing *R/S artifacts or symbols* in their design [1, 18, 22, 27, 39, 45, 46, 55, 66, 69, 73, 76, 77, 94, 99, 115, 116, 119, 124–126, 140], with some incorporating religious symbols as main elements in the artifact (e.g., the mandala in the cases of Ethereal Phenomena [77] and Wish Happiness [76], the cross in the Benedict Device's light [1], and the Tau cross shape in the Prayer Companion [39]) while others took the form of existing religious artifacts, such as altars (e.g., SenseCenser [126]) or candles (e.g., Empathy Candles [27]). These religious-inspired forms and representations also included less well-known examples of religious artifacts, such as prayer nuts in the case of Visual Voyage, Experiencing Spirituality, and Scents of Power [22]. In one case (the Font of Solace [55]) an existing stone font at St. Peter de Beauvoir Town Church in Hackney, London was digitally augmented.

Alternatively, many artifacts (19/44) took the form of *everyday artifacts* [7, 18, 20, 23, 34, 35, 45, 47, 48, 58, 76, 79, 124, 130, 131, 138, 140], including playground toys (a merry-go-round for Wish Happiness [76] and a see-saw for the Balance of Equality [45]), a ball (Transient Relics [35]), jewelry or articles of clothing (e.g., the Necklace of Silence [47] and the Hands Up, Don't Shoot Glove [20]), or even furniture (e.g., Sonic Cradle [131]). Some artifacts even took the form of simpler everyday artifacts, such as boxes (e.g., the Chests of Mindfulness [45] and the Desire Box [79]). An additional four artifacts took the form of *humanoids* in their design [34, 102, 119, 135], such as Xian'er [135] and SanTO [119], while two artifacts instead incorporated *places* as central elements of the artifact's form and representation, such as a garden in the case of the Interactive Temple [120] or landscape scenes in the Inner Garden [105]. Regardless of being drawn from religious or everyday sources, some artifacts [1, 24, 39, 138, 140], such as the Benedict Device [1] and the Blessing Companion [138], emphasized abstractness or simplicity in their design.

4.3.2 Materials. The majority of the artifacts (21/44) used *plastic* in their design [7, 18, 22, 23, 27, 34, 35, 39, 55, 58, 60, 66, 94, 102, 119, 135, 140], often in combination with other materials. Instances of this include Technkisi [102], in which a human form was 3D printed in plastic, or the My Salah Mat, which is a prayer mat that uses plastic instead of the traditional fiber [94]. Artifacts were also made of or incorporated *metal* into their design (12/44) [23, 34, 46, 58, 73, 76, 99, 102, 120, 125, 126, 135], such as the Mind Pool [73], which has a metal stand that holds the pool, and AltarNation [46], which uses copper mesh as a screen for projected images. *Wood*, which was used in the construction of eight artifacts, was another popular material [1, 45, 76, 79, 105, 126, 138, 140], as was *glass*, which was also utilized in eight artifacts [45, 58, 76, 115, 120, 124, 138, 140].

Three of the artifacts utilized or incorporated *stone* [55, 99, 140], such as the eRosary [99] that has beads made from hematite; three artifacts were made with *fabric or rope* [20, 131, 140], including the Hands Up, Don't Shoot Glove [20]; and three utilized *paper* (3/44) [126, 138, 140], such as the ThantoFenestra [126]. In addition to the materials used for constructing the artifact, many other materials were incorporated into designs, including *candles* (7/44) [27, 45, 46, 66, 119, 126, 140] (e.g., Robotic Menorah [66]), *fluids* (5/44) [22, 55, 73, 102, 138] (e.g., Technkisi [102]), *sand* (1/44) (Inner Garden [105]), *incense* (1/44) (SenseCenser [125]), and *flowers* (1/44) (SenseVase [124]). In one case (Ethereal Phenomena), there were *no tangible materials*, but rather a digital illustration of a mandala was used, which changed according to user's breathing [77]. Unfortunately, the materials utilized in the design of five artifacts [45, 47, 48, 116] were *unclear*.

4.3.3 Technologies. Of the artifacts in our corpus, 35/44 utilize some kind of *sensors* (i.e., all except [1, 7, 27, 34, 39, 48, 55, 60, 115]). The various types of sensors included capacitive sensors (e.g., Interactive Temple [120] and the Mighty Oracle [116]), gyroscopes (e.g., eRosary [99]), accelerometers (e.g., the Necklace of Silence [47]), and proximity sensors (e.g., the Desire Box [79]). A smaller portion (7/44) of the artifacts used *physical buttons* for interactions [1, 48, 58, 60, 94, 102, 140], such as the Reminder [60] and the Benedict Device [1]. 13 of the 44 artifacts used *displays* of some kind [7, 18, 23, 27, 34, 39, 45, 55, 58, 77, 79, 99, 120, 127, 135, 138, 140], which could be interactive touch displays (e.g., BlessU-2 [34]), digital displays (e.g., the Prayer Companion [39]), or physical displays (e.g., the E-Meter [23]). A number of artifacts also incorporated paired technologies, such as a *companion app or website* that provided information about the practices (7/44) [20, 47, 58, 79, 99, 115, 124] (e.g., the eRosary [99] and the Necklace of Silence [47]), while six of the artifacts, including many with aforementioned paired companion apps, required paired *smartphones* [45, 55, 58, 79, 99, 124], the exceptions of which include the Font of Solace [55], which uses a paired *tablet* for the input device, and the Box of Wishes [45], which requires any cellphone to receive a text message. Finally, several artifacts explicitly required connectivity technologies to function, specifically the *internet* (10/44) [20, 27, 39, 45, 46, 79, 115, 124] (e.g., AltarNation [46]) and *bluetooth* (6/44) [58, 66, 73, 79, 99, 102] (e.g., the Robotic Menorah [66]).

Seven of the artifacts utilized *microphones* to allow for audio input [18, 46, 47, 119, 135], including the Necklace of Silence [47] which used detected sounds to generate vibrations, while 14 artifacts used *speakers or headphones* for audio output [22, 34, 35,

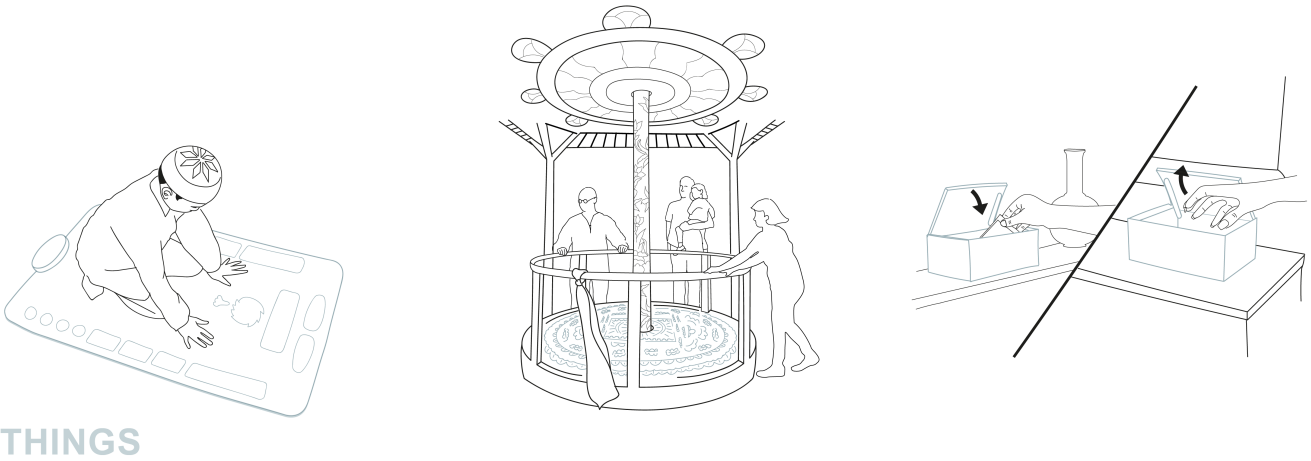

Figure 6: The illustrations show how the *things* category is represented in three R/S TIAs, each displaying different forms and representations spanning from R/S artifacts (i.e., prayer mat [94]) to R/S symbols (i.e., mandala [76]) to everyday artifacts (i.e., simple boxes [45]). Illustrations by Wolf and Claisse

46, 73, 77, 94, 105, 119, 120, 125, 131, 135, 140], including to repeat Islamic prayers (My Salah Mat [94]), provide sounds based on brainwaves for mindful reflection (Mind Pool [73]), or to offer doctrinal instruction (e.g., SanTO [119]). Other technologies that were incorporated into the artifacts included *lights* (8/44) [1, 60, 66, 115, 116, 120, 127, 140] (e.g., the Benedict Device [1]) or light-based *projectors* (10/44) [22, 46, 55, 76, 105, 120, 125, 126] (e.g., the Font of Solace [55], which projects words written on a tablet onto the water in the font, or Inner Garden [105], which projected images onto the sandbox environment). Ten artifacts utilized *motors* of various types [18, 34, 45, 47, 48, 58, 102, 119, 135] to provide vibrotactile feedback (e.g., the iQibla Zikr Ring [58] and the Vipassana Meditation Suit [48]), to move the artifacts through space (e.g., Xian'er [135]), or to articulate portions of the artifact (e.g., Technkisi [102]). A smaller number of artifacts utilized *cameras* (4/44) [20, 46, 105, 119], *paper printers* (3/44) [27, 34, 45]), *VR or AR* (2/44) [105, 124], *electromagnets* (1/44) [73], and *lighters* (1/44) [45].

4.4 Places

> *Places* are the fit between bodies and things, sites for their organization into theatres for the performance of self. And places are the flesh of social bodies, where people go to find themselves part of something larger. [86, p. 209]

Figure 7: The places category of the R/S TIA Design Space in detail.

4.4.1 Location. 14 of the 44 artifacts were designed to be used at *home* [18, 45, 46, 48, 60, 66, 79, 124–126, 138], such as the Sense-Censer [125], which is meant to be installed in the personal altar at home, and the Reminder [60], which is meant to be kept at the bedside or in the room of youth who are practicing with the artifact. Six artifacts, instead, were created to be used at a *religious site* [23, 27, 39, 119, 120, 135], with five of those artifacts being 'site specific' and only existing in one single location (e.g., Xian'er [135], which is only in the Longquan Temple in Beijing, China, and Interactive Temple, which was installed in the Hu-Ann Temple in Kaohsiung, Taiwan) and one (the E-Meter [23]) being distributed throughout Church of Scientology churches worldwide. Eight artifacts were intended for use in a *public* location [1, 34, 35, 45, 73, 76, 116], with four of the artifacts [1, 35, 73, 76] having been publicly displayed as an exhibition (e.g., Transient Relics [35], which was available for use at the Newcastle Train Station in Newcastle, Australia on Good Friday of 2019) and the four others [34, 45, 116] being artifacts that would either be permanently installed in a location (e.g., the Balance of Equality [45]) or could be moved as necessary (e.g., the Mighty Oracle [116]). An additional four artifacts [22, 102] were intended for display or have been displayed in *museums* (e.g., the Technkisi [102] exhibition at the Metropolitan Museum of Art). One artifact, the God-I-Box [140], was intended to be used at *workshops* with religious participants.

A number of artifacts (6/44) can be used *anywhere* [7, 20, 47, 58, 94, 99] based primarily on being small artifacts that are worn or held and involve practices that may occur at various times throughout the day (e.g., the Necklace of Silence [47], and the Hands Up, Don't Shoot Glove [20]). The remaining artifacts either were artifacts for which the intended location of use was *unclear* (3/44) [77, 105, 131] or were artifacts that implicated multiple locations (2/44) [55, 115], such as the Bönewebben (Prayer Web) [115] for Allhelgona in 2014 and 2015, which allowed a person anywhere to type in a prayer which would turn on a light in specific graveyards or public spaces,

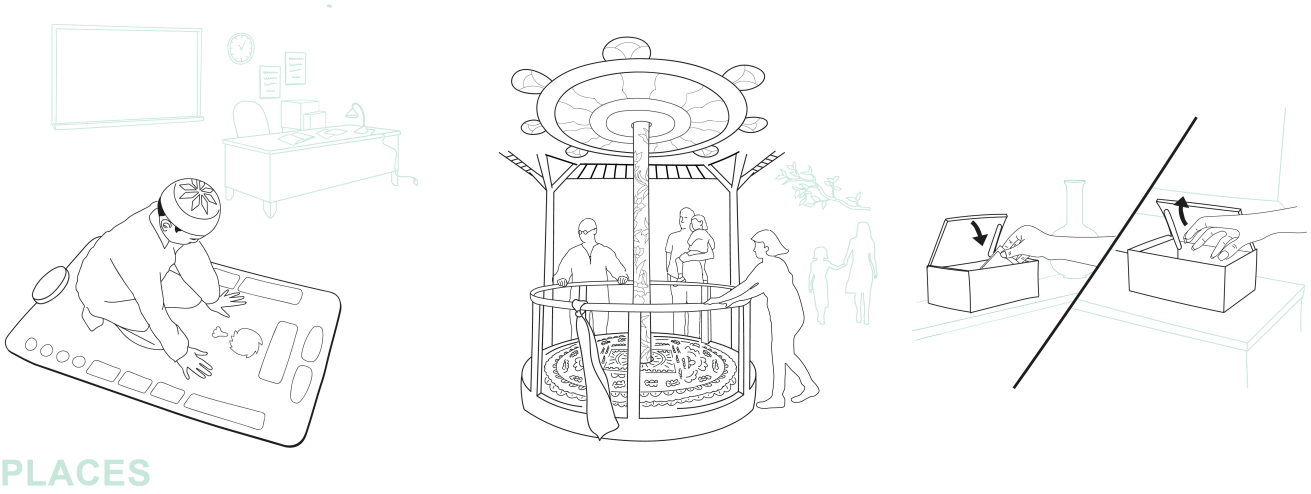

Figure 8: The illustrations show how the *place* category is represented in three R/S TIAs, each showing different locations where the artifacts are used: anywhere, including in a school environment [94]; in a public place [76]; or at home [45]. Illustrations by Wolf and Claisse.

or the Empathy Candles [55], which involved the lighting of a candle at the St. Peter de Beauvoir Town Church in Hackney, London but could be done by practitioners from anywhere.

4.5 Practices

> *Practices* are bodies, things, and places put to work, put on display, put into circulation, exchanged and hoarded, heard, smelled, fondled, destroyed. Practices are ways of activating bodies, things, and places, recognizing in their interrelations a presence or voice or power that engages humans and their institutions and communities. [86, p.209]

4.5.1 R/S Practices. The most frequently supported R/S practice (15/44) is *prayer* [7, 18, 39, 45, 55, 58, 94, 99, 115, 119, 126, 135]. In terms of supporting prayer, the means of doing so by the artifact include (but are not restricted to) counting [7, 58, 99], tracking [58, 99], teaching/training [94, 99, 135], guiding or leading [119, 135], and facilitating co-practice [18]. The next most frequent R/S practice supported by the artifacts (10/44) is *R/S learning* [22, 35, 45, 119, 135], with instances such as the teaching of religious doctrine by a robot (e.g., SanTO [119] and Xian'er [135]) or via interacting with the artifact in a particular way (e.g., the Balance of Equality [45] and the Light of Connectedness [45]). Several artifacts (8/44) were explicitly designed for the purpose of *virtue/value development* [27, 47, 55, 60, 76, 79, 116, 138], with artifacts dedicated to compassion [76]; empathy [27, 55]; patience [79, 138]; divine intuition [116]; silence [47]; and spiritual, social, intellectual, and physical development broadly [60].

Six artifacts were intended to support personal *reflection* [34, 60, 73, 120, 138, 140] through a variety of means, such as inducing it (e.g., Mind Pool [73] and Interactive Temple [120]) or provoking it (e.g., BlessU-2 [34] and the God-I-Box [140]), while an additional five artifacts were intended to support *remembrance or commemoration* [66, 115, 124–126], both of religiously significant historical events (the Robotic Menorah [66]) or of those who have died (e.g., ThanatoFenestra [126]). A further five artifacts were explicitly designed to support *meditation* [46, 48, 77, 105, 131] through means such as sound feedback (Sonic Cradle [131]), haptic feedback (Vipassana Meditation Suit [48]), or play (Inner Garden [105]), with one artifact (AltarNation [46]) intended to support the co-practice of it.

In addition to these practices, there were a number of other practices that were supported such as *blessings* (3/44) (transmitting them in the case of BlessU-2 [34] and the Benedict Device [1] and recognizing/encountering them in the case of the Blessing Companion [138]), *unburdening* (2/44) (which has similarities to the religious act of confession and was illustrated in Technkiski [102] and the Font of Solace [55]), religious *counseling* (the E-Meter [23]), *fasting* (The Chests of Mindfulness [45]), *warding* (Hands Up, Don't Shoot Glove [20]), *worship services* (God-I-Box [140]), and *religious discussion* (God-I-Box [140]).

4.5.2 Time. Three-quarters (31/44) of the artifacts are intended to be used either *at-will or on-demand* [1, 20, 22, 27, 34, 39, 45–48, 55, 60, 73, 77, 79, 99, 102, 105, 116, 119, 120, 124–126, 131, 135, 138, 140], with some being so based upon when one might visit a specific location (e.g., Xian'er [135] or Interactive Temple [120]) and others based on when the individual might feel like practicing (e.g., the Desire Box [79] or the Reminder [60]). The remainder of the artifacts exhibit much more regularity, with four based on *daily* interactions (the E-Meter [23] and the Bell, the Voice, and the Beads [18]), three based on the *multiple daily* prayers in Islam (My Salah Mat [94], the Digital Tasbih Counter [7], and the iQibla Zikr Ring [58]), and five based on *special occasions* (e.g., Bönewebben (Prayer Web) for Allhelgona in 2014 and 2015 [56, 115], Transient Relics for Good Friday in 2019 [35], and Wish Happiness for the Vivid Sydney Festival in 2018 [76]). Additionally, one artifact exhibits a

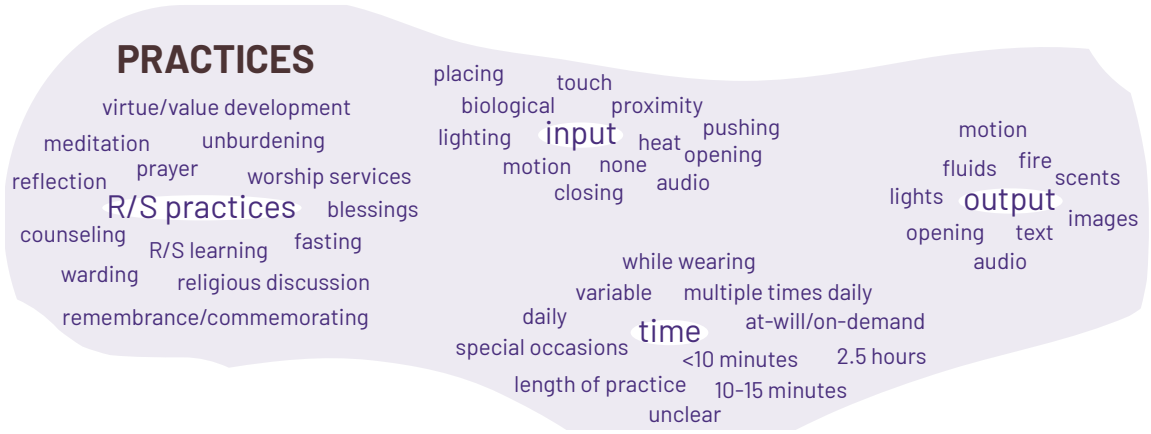

Figure 9: The practices category of the R/S TIA Design Space in detail.

combination of use-moments (the Robotic Menorah [66] which is used daily during Hanukkah), and one offers the possibility of both at-will or special occasion-based use (the Chests of Mindfulness [45], which are used for the coordinated fasting of two individuals).

A fewer number of artifacts have more explicit clock time lengths attached to them, with four exhibiting brief durations of *less than 10 minutes* (Interactive Temple [120], BlessU-2 [34], Transient Relics [35], and the Robotic Menorah [66]), two requiring *10-15 minutes* (Ethereal Phenomena [77] and Sonic Cradle [131]), and one requiring approximately *2.5 hours* (the E-Meter [23]). Two artifacts, the Hands Up, Don't Shoot Glove [20] and the Necklace of Silence [47], are used *while wearing*. Some practices, however, imply artifact uses based upon *how long the practice lasts* rather than a specific amount of clock time (6/44) [7, 46, 48, 58, 94, 99], such as with the Digital Tasbih Counter [7] where the length of time using the artifact is based on the length of time it takes to complete the prayers. Other practices with the artifacts are *variable* in terms of length of time (18/44) [1, 22, 27, 39, 55, 60, 76, 79, 115, 119, 124–126, 135, 138, 140], with some of them based upon how long the artifact may hold someone's attention (e.g., Wish Happiness [76]) and some based on how long someone might feel they want or need to practice with it (e.g., the Benedict Device [1]). Finally, the use-time of 11/44 artifacts was *unclear*. When frequency and duration are combined, several interesting time cases appear, such as the E-Meter [23], which is a daily practice for approximately 2.5 hours per day for five straight days, and the Blessing Companion [138], which has an at-will/on-demand flexibility in terms of frequency but is stretched over a variable amount of time (up to weeks).

4.5.3 Input. One of the predominant input methods for the artifacts is *touch* (13/44) [22, 23, 27, 34, 55, 66, 79, 115, 116, 119, 120, 135]. The touch inputs vary between touches to screens (e.g., BlessU-2 [34] and the Font of Solace [55]) and touches to surfaces of artifacts, including touching the hand/arm of the SanTO statue [119], touching the palm of the Mighty Oracle [116], and touching the inside of the Experiencing Spirituality and Visual Voyage prayer nuts [22]. Similarly, *pushing* is an input method for 13/44 artifacts [1, 7, 27, 35, 48, 58, 60, 76, 94, 99, 102, 105, 115]. This group of artifacts can be divided into those that involve the pressing of physical buttons to activate the artifact (e.g. Technkisi [102], the Vipassana Meditation Suit [48], the Benedict Device [1]), inputting text via pressing the keys of a keyboard (e.g., the Empathy Candles [27]), or pushing the artifact or parts of it (e.g., Wish Happiness [76], where the merry-go-round needs to be pushed, or Transient Relics [35], where the balls are rolled). Seven artifacts utilize *motion* as input [20, 35, 46, 48, 99, 120, 126], which can include the movement of people in and through space (e.g., the Interactive Temple [120]), the movement of the artifact itself in space (e.g., eRosary [99] and the Necklace of Silence [47]), or the motion of another portion of the artifact (e.g., the flicker of the candle that has been lit in the ThanatoFenestra [126]), while five other artifacts use *proximity* [46, 79, 119, 120, 138] either in addition to or instead of motion (e.g., the Blessing Companion [138] and the Desire Box [79], which is only active when the practitioner is within a certain range of feet (4-12 feet, the 'zone of practice') from the artifact).

Some artifacts (6/44) use *biological* inputs [23, 73, 77, 102, 105, 131], such as brainwaves (e.g., Technkisi [102] and Mind Pool [73]), breathing (e.g., Ethereal Phenomena [77] and Inner Garden [105]), and body electricity (the E-Meter [23]). Six other artifacts are activated via *audio* [18, 47, 119, 135], such as by voice (e.g., Xian'er [135] and the Necklace of Silence [47]) or by other noises like the rubbing of prayer beads (The Beads [18]). Additionally, there are artifacts (3/44) activated either via *opening* (the Visual Voyage and Scents of Power prayer nuts [22]) or *closing* the artifact (the Desire Box [79]). A further seven artifacts activate when another item is placed into it or on it [45, 119, 124, 125, 140], including the *placing* of incense into a small container (SenseCenser [125]), the placing of items on a small pedestal (God-I-Box [140]), or the placing of two people onto a see-saw (the Balance of Equality [45]). Finally, three artifacts use the act of *lighting* a candle as an input [45, 46, 126] while one uses the *heat* from the candle as an additional input in a 'chained' interaction (ThanatoFenestra [126]), which requires the practitioner to light a candle in order for the artifact to detect the heat and movement of the candle's flame as inputs. One artifact

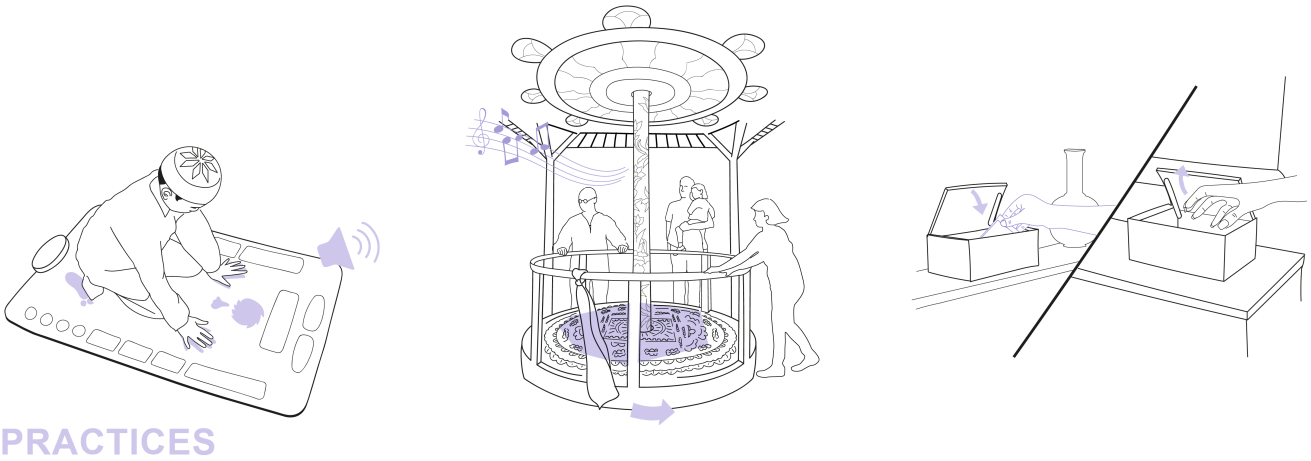

Figure 10: The illustrations show different inputs and outputs from the *practices* category represented in three R/S TIAs, including pressing the prayer mat with one's feet, hands, or head which triggers sound [94]; pushing the merry-go-round to trigger audio-visual outputs [76]; and placing an item in one chest which triggers another chest to open [45]. Illustrations by Wolf and Claisse.

(the Prayer Companion [39]) has no input from the user (*none*) for the system to function.

4.5.4 Output. The physical *motion* of the artifact, or parts of the artifact, is an output for 12/44 artifacts [18, 23, 34, 45, 47, 48, 58, 73, 76, 102, 119, 135], including the coordinated movement of portions of the artifact to create the bust of a person (Technkisi [102]), the raising of the robot's arms in a blessing (BlessU-2 [34]), and the ripples of fluid in a pool (Mind Pool [73]). Many of the artifacts (14/44) have *audio* as an output [22, 34, 35, 46, 73, 76, 94, 105, 119, 120, 125, 131, 135, 140], including sounds of religious life in medieval times (the Experiencing Spirituality prayer nut [22]), the sounds of an angry mob during the Passion of Christ (Transient Relics [35]), and the sounds of nature (e.g., Interactive Temple [120] and Inner Garden [105]), while the sense of smell is activated through a *scent* output in two artifacts: SenseCenser [125] and the Scents of Power prayer nut [22]. *Fluids* are an output for one artifact (Technkisi [102]) in the form of tears, and *fire* is an output for two artifacts: the Empathy Candles [27] (which are lit remotely via a companion application) and the Lights of Connectedness [45] (in which a candle lit elsewhere lights a companion candle). Ten artifacts, meanwhile, have *light* as an output [1, 18, 46, 60, 66, 94, 115, 116, 140], including lightbulbs in a graveyard or public place (Bönewebben (Prayer Web) [115]), a lighted form of the cross (the Benedict Device [1]), or a small signal light to tell the other person it is time to light the menorah candle (Robotic Menorah [66]). Two artifacts have the *opening* of a box as an output: the Chests of Mindfulness [45], which opens when someone places an object into a remotely paired box, and the Desire Box [79], which opens when the timer has run down following a successful time spent in the 'zone of practice.'

Many artifacts in the corpus have *images* as an output (16/44) [18, 20, 22, 46, 76, 77, 105, 115, 120, 124–126, 138, 140], with some being static images on a screen (e.g., SenseVase [124], which is a virtual arrangement of flowers based on the flowers placed in an actual vase), others being dynamic images on a screen (e.g., Ethereal Phenomena [77], which is a mandala that changes based on one's respiration), others being projected static images (e.g. the Experiencing Spirituality prayer nut [22], which is a projection of illustrated scene from medieval times), and finally others that are dynamic projected images (e.g., Interactive Temple [120], which are based on the movement, proximity, and interaction of the practitioner in the temple). Of particular note is the Hands Up, Don't Shoot Glove [20], which sends photographs to a website when the wearer makes the 'Hands Up' motion. Finally, nine artifacts have *textual* outputs [7, 27, 34, 39, 45, 55, 58, 79, 99], which can be in the form of text on companion app (e.g., eRosary [99]), a running LED sign (the Prayer Companion [39]), or a digital display and textual print-out of a prayer or blessing (e.g., Empathy Candles [27] and BlessU-2 [34]). It is worth highlighting that several artifacts, or combinations of related artifacts, attempt to provide multi-sensory outputs, such as the SenseCenser [126], which can provide both scent and audio output in addition to visual output, and the three prayer nuts (Visual Voyage, Experiencing Spirituality, and Scents of Power [22]) which, in combination, offer auditory, visual, and olfactory stimulation.

5 DISCUSSION

In this section we build on insights from our review to expose design considerations when designing for tangible interaction in R/S contexts. As part of this, we further highlight novel and under-explored areas for research and design in the following six areas: Representation; Participatory and Design-Led Process; Community Aspects of R/S Practices; Spiritual Informatics; Tangibility, Materiality, and Embodiment; and Breaking Boundaries.

5.1 Representation

One immediate fact that comes to attention when reflecting on the artifacts in the corpus is that the artifacts demonstrate a "long tail distribution" in terms of the representation of R/S traditions (i.e., many artifacts from a few traditions and very few artifacts from many other traditions). Christianity (20/44) and Buddhism (10/44) serve as the R/S context for nearly three-quarters of the artifacts in our corpus, with other R/S traditions seeing far fewer instances. This fact raises significant questions worth further examination, such as whether there might be certain reasons within academia and industry that favor designs from these backgrounds (e.g., systemic institutional bias) or, perhaps, if it reflects the possibility that some R/S traditions rely less on material artifacts in their R/S practices (something that material religion would likely disagree with). Regardless, it seems incumbent on those who work in this space to seek additional examples from a wider variety of R/S contexts, an act that would enrich the field and contribute to our understanding of the place of R/S in contemporary life. For instance, the Hands Up, Don't Shoot Glove [20], in its utilization of Vodou in its design, represents a fascinating, beautiful, and timely interpretation of the use of wards (e.g., amulets) to protect the wearer, and as such, stands as a tantalizing taste of what other artifacts may be out there (or could exist). Additionally, with the rise of New/New Age Spirituality [44, 114], other novel R/S traditions and practices are coming into being and attracting new practitioners, and these traditions and practices should also be represented in this research and design space. Finally, incorporating more diverse R/S perspectives will enrich the design field, as has been noted by Hammer [42], who eloquently articulates the value of considering concepts from Judaism in HCI, or as can be imagined when considering Tasa and Yurtsever's [117] work on Sufism and its potential implications for interaction design. And while some efforts to expand this design space are emerging [e.g., 41, 71], much more work is yet to be done.

There is a second dimension to the question of representation that may also be raised; that is, how to account for, and design for/with, those who are not religious but may be spiritual. Our inclusion of mindfulness as a R/S tradition was partly inspired by an attempt to capture how mindfulness can be (although not always is) a type of spiritual practice, a fact that reflects Akama et al.'s perspective that "when we talk about mindfulness...we are talking about something that is not specific to a type of faith, but allows us to alter modes of thinking, feeling and being" [3, p. 632], an understanding that squares well with our definition of spirituality. For instance, both Mind Pool [73] and Inner Garden [105] invoke and involve spiritual dimensions of the human being. The open question, though, is how to design for a group of individuals (such as the "spiritual but not religious") who have no cohesive set of R/S practices, with an additional question being how to recognize and account for practices that might not traditionally be considered (or might not look like traditional) R/S practices (e.g., aromatherapy) or even articulated as such by practitioners but may be functioning in a similar manner as traditional R/S practices. Will it be the case that each R/S TIA must be entirely bespoke to each individual and involve broader notions of what can be considered religious or spiritual? Or should designers embrace a perennial philosophy perspective [109] and identify a set of transcultural and/or transreligious values (or perhaps even a set of technomoral virtues [128]) in order to design universal R/S TIAs that can be broadly adopted? Or both? Or something else entirely? In any case, the "spiritual but not religious" and New/New Age Spirituality also raise important questions in terms of representation.

5.2 Participatory and Design-Led Process

Overall, there is little description or documentation of the design process reported in the academic published sources. This may be partly due to the word count, which is limited in certain types of publications (e.g., extended abstracts) that make up most of the academic examples in our corpus (see Appendix 1). Here we turn back to previous works that highlight the value of design-oriented research like RtD for tangible interaction [129], and most recently, the value of iterations and field deployment to document new ways of being in the world through longitudinal deployment of TIAs [113]. In our corpus, iterative design is explicitly described for a quarter of the artifacts but only four report field deployments. Previous research has highlighted the challenging nature to design for R/S contexts in HCI [12, 57], making a critical mindset and a reflective approach indispensable. Thus, approaching design in R/S contexts with RtD perspectives and methods might be valuable and enhance theory-formation based on created artifacts [38].

Another interesting approach for future work might be to reflect on what it means for HCI researchers, interaction designers, and practitioners to engage in design processes for R/S contexts. As for any other context, designing for R/S contexts requires an in-depth examination of the contextual givens and peculiarities. We argue that this might in itself be a form of R/S practice, "practice through design," which allows for practitioners to explore their own understandings of, and experiences with, their R/S views through the attempt to materially articulate them through design, which, in a way, is a type of thinking through doing [32, 67].

In addition, we note that only a small number of artifacts result from collaboration between academia and R/S contexts, and seven are associated with a co-design process [27, 39, 55, 120, 135, 138]. Here we identify a gap in the design process for R/S TIAs, which aligns with recent calls in the HCI community for more transdisciplinary collaborations when designing in R/S contexts [81, 82, 140]. Especially in connection with the aforementioned idea of empowering R/S practitioners to make their own decisions about the design of R/S technologies, research on (participatory) design processes is becoming increasingly important. This also applies to designing for more formally organized R/S communities where traditions and rituals have evolved over centuries, and thus simply imposing novel technology-mediated rituals from the outside will not work [140]. Therefore, novel methods are needed to support designers in exploring future possibilities of R/S technologies with those affected, with a recent example adopting a provotyping approach to explore possible futures of technology-mediated religious rituals together with congregants and pastors [140].

5.3 Community Aspects of R/S Practices

Experiencing a sense of community and performing rituals in groups are deemed essential aspects of R/S practice [24, 139, 140,

142] and previous research has highlighted the interpersonal needs of people when using technology for religious purposes [104]. However, the majority of artifacts featured in our corpus are designed to be used by an individual person (e.g., one-to-artifact) with limited examples of artifacts supporting one-to-one or group interaction, such as artifacts that are co-located (e.g. [39, 126, 135]) or used remotely to establish some levels of connection with other members of a community (e.g. [46, 66, 124]). The lack of further examples highlights an opportunity to develop our understanding of how TIAs can support community aspects of R/S practice and a need to consider groups and communities as necessary components of R/S practices. More specifically, we see the potential to explore varieties of connection or arrangements between bodies and artifacts (i.e., one-to-one, one-to-many, many-to-artifact, etc.) as well as the obstacles academic designers might face in designing artifacts that facilitate these types of arrangements (e.g., it might be easier to create an artifact and run user studies when the artifact only requires a single person). Additional work focused on the community aspects of R/S practices will also contribute to exploring what embodied facilitation, the shaping of emerging social configurations through TIAs, might mean in R/S contexts [53] while also helping to further explore the *bodies* dimension of the material religion framework through considering "social bodies" [86, p.209]. Overall, additional attention to this factor will help build on recent research conducted during the COVID-19 pandemic [24] that reports how collective experiences of religion and spirituality are still relatively under-explored in HCI and that encourages a community-centered approach to design for R/S practice.

5.4 Spiritual Informatics

Another interesting possibility for R/S TIAs is in relation to personal informatics. Personal informatics is an established class of digital tools that supports users in collecting and reflecting on personal information [106], a perspective that squares well with many approaches in R/S focused on one's spiritual progression or spiritual development. This approach aligns to a certain degree with the Quantified Self phenomenon [137] characterized by gaining self-knowledge through numbers with the aim to improve areas of one's life [70, 106]. Common examples in HCI include research that explores the potential of tracking health-related information to support self-management of health conditions and broader wellbeing or self-care [e.g., 6, 25, 95, 132]. Examples have also demonstrated the value of tracking technologies for supporting self-reflection, self-discovery, and empowerment [5, 6, 78]. However, work that explicitly considers R/S practices in personal informatics is extremely limited, with Hoefer et al.'s articulation of *faith informatics* [50] standing as one of the few examples. In our corpus, we identified artifacts that support prayer through counting [7] and tracking [58, 99] religious or spiritual-related data. Tracking and goal-setting features can be valuable for supporting practitioners in establishing a daily routine for their R/S practice, but there seems to be space to explore more robust systems. Indeed, religion and spirituality are intertwined with living life [139, 144] and, therefore, future work on what we term 'spiritual informatics' could build on previous models like 'lived informatics' [106] to design tools that recognize the everyday challenges and messiness of people's lives while accounting for the R/S values and goals that individuals deem important. It is also important to emphasize that R/S practice is intrinsically linked to people's wellbeing, and here we turn back to the missed opportunity for HCI to consider R/S practice in the development of supportive tools for health and wellbeing [112] and argue that future work on spiritual informatics may address this gap. However, we also highlight critical perspectives on personal informatics and tracking tools, which are well established in the HCI community, such as the pitfalls of a quantified approach and data driven systems [21, 25], and recommend that designers carefully consider the specific dimensions of self-tracking technologies [25] and their implications when used for R/S purposes.

5.5 Tangibility, Materiality, and Embodiment

R/S practices often aim at making tangible the intangible. For example, Christian worship services are often conceptualized as "communicative gatherings of believers who invoke an external power and seek to make it tangible for those gathered" [87, 139, p. 2]. As such, their embodied aspects, or their spatial interactions [53], are of utmost importance, including specific body movements, procedures, orientations of bodies within a specific place, incorporation of specific things into the practice, and so on. However, the strong focus of techno-spirituality research and techno-spiritual re-purposing practices [9] on appropriating and re-purposing digital technologies such as streaming technologies neglects the embodied aspects of R/S practices. One aim of this review is to provide a collection of alternative examples that address the tangible and embodied nature of R/S practices as a resource for others to draw upon. Although our corpus can be such a resource, we would like to point out that the tangible and embodied aspects of R/S TIAs are little reflected in relevant publications which leaves much room for future research.

Our corpus analysis revealed several interesting trends regarding a material perspective [31]. Some materials used to build or integrate into the artifacts, like candles, incense, or natural materials, connect well with the R/S context from a macro- or expressive representations perspective, focusing on an artifacts' material meanings within a cultural and application context [31, 53]. However, the broader meaning of the most common material, plastic (used in 21/44 artifacts), might not always correspond with intended experiences. In some cases, plastic was deliberately chosen. For example, the God-I-Box was 3D printed purposefully to refer to a do-it-yourself culture and thus to challenge top-down structures in formally organized religious rituals such as worship services [140]. In many other cases, however, no rationale for or reflection on material selection was documented. Given the specifics of the R/S context, consisting of many symbols and meaning-laden rituals, reflecting on meanings conveyed through and experiences supported by material choices [31, 53] seems even more essential. Therefore, we invite researchers and designers to carefully consider and reflect on material choices in future work.

We also invite R/S TIA designers to consider the design of artifacts that can be worn. Other than the Hands Up, Don't Shoot Glove [20] there isn't another article of clothing represented in our corpus. There are accessories, such as jewelry (e.g. the Necklace of Silence [47]), but given the centrality of religious outfits, including special ceremonial dress, it is an area that is surprisingly

under-represented in the design of R/S TIAs. With readily-available LED strips and other emerging technologies (e.g., EL wire, electroluminescent textiles, etc.), there seems to be a wide range of possibilities for the construction of R/S TIA garments. The design of clothing might also connect designers with other R/S traditions that already envision an incorporation of the technological with the spiritual, such as technopagans [136] who may be interested in incorporating electronics into ritual/religious dress. Taken together, clothing seems to be another space in which materials, tangibility, and embodiment can be further considered and explored.

5.6 Breaking Boundaries

The development of the R/S TIA Design Space represents the possibilities that may come when boundaries are broken. One of those boundaries is between academic disciplines which have, unfortunately, been siloed off from each other in ways that keeps knowledge from migrating or cross-pollinating. In the case of material religion, and in addition to what has been mentioned previously, several interesting concepts may offer greater insights into the design of TIAs. For instance, Morgan [89] raises the idea of *remediation*, which is the "reissuing of a product in a new medium or format" [p. 25]. In our corpus, we have a wide range of artifacts that demonstrates this kind of remediation (e.g., the Digital Tasbih Counter [7]) while also representing another form of *re-mediation*: the introduction of technology (media) into the design of a new version of the artifact (e.g. My Salah Mat [94]). This concept seems to open a myriad of considerations on not only the process of re-mediating (i.e., adding technologies to) existing R/S artifacts but also how such re-mediations may involve the use of different materials than were used in the original versions and with what possible consequences for the practitioner. Connected to this point is another concept that comes to material religion from anthropology: Keane's idea of *bundling* [61, 62], which is defined as "the contingent coexistence of an indefinite number of qualities in any object, which always exceeds the purposes of the designer" [62, p. 230]. This concept seems particularly important for designers of R/S TIAs to keep in mind throughout the design process as a way to remind themselves that, despite their best attempt to control the meaning and interpretation of the artifact through design decisions and outcomes, it will always exceed their ability to control its interpretation and reception, especially with R/S artifacts that are symbolically rich. Thus, while material perspectives in HCI also take note of the implications of material choices (as noted in the previous section), breaking boundaries by engaging with anthropological and/or material religion perspectives through concepts like remediation and bundling offers HCI researchers and designers alternative ways to see and understand the potential implications of design choices for R/S contexts.

A second type of boundary that seems to be broken by the artifacts in our corpus, and which demands further contemplation and reflection, is the breaking of the boundary between R/S and non-R/S contexts. For instance, a sizeable number of the artifacts are intended to be (or were) displayed in non-R/S settings, such as the three prayer nuts [22], the Balance of Equality [45], and Wish Happiness [76]. This boundary breaking simultaneously raises questions as to the ethicality of placing R/S artifacts into public spaces (particularly for those who might be averse to such placements) and to what responsibilities designers or artists who create these R/S TIAs have in terms of transparency and disclosure of the artifact's purpose and meaning [83]. On the other side of this potential controversy, however, is the possibility of bringing into public view artifacts that draw attention to the deeper dimensions of our lives as humans (e.g., the spiritual) that may help to raise questions about contemporary perspectives that devalue or reduce the individual to a cog in one of a variety of machines (e.g., economic, technological, etc.). For instance, maybe it's not such a bad thing for people to be reminded about the value and act of compassion by interacting with Wish Happiness [76], even if it explicitly draws from a specific R/S tradition? In the end, this is another type of boundary breaking (among several others) that emerges from engaging with R/S TIAs and warrants further consideration.

5.7 Limitations

We acknowledge the limitations of this review. First, as highlighted in our positionality statement, the way we conducted the review (i.e., inclusion and interpretation of artifacts) was influenced by our personal motivations and expertise and also by our individual R/S backgrounds. To mitigate potential bias, our team includes researchers from various fields who bring different perspectives on the topic of this review which are grounded in a broad range of experiences and conceptualizations of religion and spirituality. We used an iterative and discursive peer debriefing process to ensure that our interpretation and conclusions were grounded in the data. During the review process, we also encountered several challenges; for example, published information (i.e., academic papers) on the artifacts was not always explicit with regard to the categories we identified. Additionally, there may be many other published artifacts which creators and users would identify as being connected to, or examples of, R/S practices or R/S purposes but which are not explicitly described as such in the text (i.e., there is no use of the words religious or spiritual in either the abstract or the body of the text). Future research should seek to better understand how to account for and locate these examples.

In addition, examples of TIAs exist beyond research articles. We relied on our personal knowledge and internet search abilities to find more artifacts for our corpus, especially for those created by R/S communities, which was challenging via traditional search. In this case, we acknowledge that we may have missed a number of relevant artifacts, which were either not published online or which we just did not know about and/or didn't know how to find. Our choice to focus on tangible interaction [53] has also limited the scope of our review. For example, we excluded a large body of work on techno-spirituality, including artifacts which focused only on virtual interactions (i.e., VR/AR). We, therefore, re-emphasize that our review exclusively focuses on artifacts that support some forms of tangible, embodied, and multi-sensory interactions and is not intended to be comprehensive. We envision the R/S TIA Corpus as a growing resource for the TEI community, and we will update it as we continue to explore this design space[2]. By publishing it online, we invite other researchers to use it for research and/or design and to contribute to the design space by identifying more artifacts

[2]The corpus is available online at https://spiritedhci.org/rs-tia-database/

to be added to the corpus by emailing the SPIRITED Collective (spirited.hci@gmail.com) or by completing an online form[3]. Over time, we hope this can serve as a generative and design-oriented resource for inspiring innovative work in R/S contexts.

6 CONCLUSION

In this paper we present a review of 44 TIAs which were collected from various fields to define a design space for TIAs in R/S contexts. We review a broad range of bespoke artifacts designed to mediate some forms of tangible, embodied, and multi-sensory interactions, further demonstrating the centrality of tangible and embodied experiences in R/S practice. We argue that this is under-explored in HCI, and our corpus provides a starting point for developing a design space. This work is timely as there has been an increasing use of techno-spiritual re-purposing in R/S contexts as a result of the COVID-19 pandemic, which risks diminishing people's experiences while deeply altering R/S practices [24, 30, 139, 140]. With our review, we demonstrate the value and importance of tangibility and embodiment in technology-mediated practices for R/S contexts. We also argue for the potential of designing for tangible interaction to create richer and more meaningful experiences that align with the needs and aspirations of R/S communities. We contribute to HCI research by framing a design space as a form of intermediate-level knowledge [33, 52], which offers both descriptive knowledge about the qualities of TIAs and generative knowledge to inspire novel research and design in this space, and we see the R/S TIA Corpus as a growing resource to inspire designers, researchers, and R/S practitioners for future artifact creation and research in R/S contexts. Finally, based on our review of 44 TIAs, we expose design considerations when designing for tangible interaction in R/S contexts, and highlight six novel and under-explored areas: Representation; Participatory and Design-Led Process; Community Aspects of R/S Practices; Spiritual Informatics; Tangibility, Materiality, and Embodiment; and Breaking Boundaries.

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A OVERVIEW OF THE R/S TIA CORPUS

Table 1: The 44 artifacts of the final corpus. When no names were documented, we assigned some (italics). The abbreviations in the venue column mean: Extended abstract (EA), full paper (FP), workshop (WS), work in progress (WIP), short paper (SP), and demonstration (demo).

Name	Year	Authors & Designers	Venue	Reference
AltarNation	2002	Hlubinka et al.	CHI (EA)	[46]
Balance of Equality	2020	Hemmert et al.	MuC (SP)	[45]
The Beads	2023	Chatting et al.	DIS (WS)	[18]
The Bell	2023	Chatting et al.	DIS (WS)	[18]
Benedict Device	2008	Acosta	N/A	[1]
Blessing Companion	2023	Wolf et al.	CHI (FP)	[138]
BlessU-2	2017	Protestant Church (Hesse & Nassau)	N/A	[34, 75]
Bönewebben (Prayer Web)	2014	Svenska Kyrkan	N/A	[56, 115]
Box of Wishes	2020	Hemmert et al.	MuC (SP)	[45]
Chests of Mindfulness	2020	Hemmert et al.	MuC (SP)	[45]
Desire Box	2023	Markum	DIS (WS)	[79]
Digital Tasbih Counter	unknown	unknown	N/A	[7]
E-Meter	1950s	Church of Scientology	N/A	[23]
Empathy Candles	2014	Coulton et al.	DIS (EA)	[27]
eRosary	2019	Pope's Worldwide Prayer Network	N/A	[99]
Ethereal Phenomena	2022	Malaver Turbay et al.	TEI (WIP)	[77]
Experiencing Spirituality	2016	Chu et al.	DIS (FP)	[22, 69]
Font of Solace	2014	Huck et al.	MINDTREK (FP)	[55]
God-I-Box	2023	Wolf et al.	DIS (FP)	[140]
Hands Up, Don't Shoot Glove	2022	Chin	interactions	[20]
Inner Garden	2017	Roo et al.	CHI (FP)	[105]
Interactive Temple	2010	Tsai et al.	CAADRIA (FP)	[120]
iQibla Zikr Ring	2019	Shao & Younes	N/A	[58]
Light of Connectedness	2020	Hemmert et al.	MuC (SP)	[45]
Mighty Oracle	2023	Tanenbaum and Khan	DIS (WS)	[116]
Mind Pool	2013	Long et al.	CHI (EA)	[73]
My Salah Mat	2020	My Salah Mat	N/A	[94]
Necklace of Silence	2023	Hoefer	DIS (WS)	[47]
Prayer Companion	2010	Gaver et al.	CHI (FP)	[39]
Reminder	2023	Jones and Seppi	DIS (WS)	[60]
Robotic Menorah	2021	Klein et al.	HRI (EA)	[66]
SanTO	2019	Trovato et al.	RO-MAN (FP)	[119]
Scents of Power	2016	Chu et al.	DIS (FP)	[22, 69]
SenseCenser	2018	Uriu et al.	DIS (demo)	[125]
SenseVase	2021	Uriu et al.	CHI (FP)	[127]
Sonic Cradle	2012	Vidyarthi et al.	DIS (FP)	[131]
Technkisi	2015	Randhawa	N/A	[102]
ThanatoFenestra	2010	Uriu et al.	DIS (demo)	[126]
Transient Relics	2020	Fraietta	TEI (FP)	[35]
Vipassana Meditation Suit	2023	Hoefer	DIS (WS)	[48]
Visual Voyage	2016	Chu et al.	DIS (FP)	[22, 69]
The Voice	2023	Chatting et al.	DIS (WS)	[18]
Wish Happiness	2020	Mah et al.	TEI (FP)	[76]
Xian'er	2015	Monks of Longquan & industry/acadmic partners	N/A	[135]