Design Process of 'Shredded Lives': An Illustrated Exploration

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Abstract
This pictorial illustrates an autoethnographic exploration of the first author's design practice for the data physicalization "Shredded Lives: A Decade of Migrant Loss." It emphasizes the parallel development of seven design components -- Interaction Mode, Technology, Data Representation, Physical Configuration & Scale, Dataset, Engagement Mode, and Spatial Experience. This flexible, non-hierarchical approach allows each of the seven design components to inform and evolve alongside the others, stemming from a desire to thoroughly explore the design space without confinement by initial restrictions. As these design components overlap and intersect, dynamic interactions occur, leading to the manifestation of design ideas.

Keywords
Autoethnography; Design Thinking; Design Process; Data Physicalization.

Introduction
Shredded Lives: A Decade of Migrant Loss is a physical data art installation exploring the complex socio-political dynamics of global migration that often leave the stories of the deceased erased or obscured by mere statistics. These migrants, whose deeply moving and tragic experiences are disturbingly minimized in global discourse, leave behind untold stories that demand recognition and impact. Shredded Lives aims to shed light on this issue by blending art and data to illuminate these overlooked narratives. Leveraging KiriPhys (1) —a data physicalization technique inspired by the Japanese art of Kirigami (paper cutting)—this project embodies a decade of migration data from the International Organization for Migration (IOM), representing over 63,000 documented deaths. Constructed from lightweight paper-cut structures, this installation represents regions most impacted by migration fatalities: the Mediterranean, Africa, the Americas, and Western Asia. The installation features expanded paper-cut structures where the height/depth of each expansion represents the number of deaths in each region, with separate expansions dedicated to identified fatalities and to those who remain unidentified. The causes of death are communicated through variations in color and the severity of the crisis each year through variations in texture. Visitors are invited to navigate around and beneath the physicalization above them and to physically interact with it by stretching the structures. Through this interaction, the installation focuses on the scale of loss and challenges participants to confront the hidden layers of human experiences shaped by migration.

In this pictorial, we describe the design journey through which we arrived at the final design of

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"Shredded Lives." This work contributes to the growing awareness in visualization that 1) design processes in data-driven art vary sometimes subtly, sometimes powerfully (2;3), and 2) expanding the variety of approaches enriches the community. We took a self-reflective approach in which the first author conducted an autoethnographic study of their design processes during the iterative exploration of the design space of the artwork. This process revealed the parallel development of seven design components: Interaction Mode, Technology, Data Representation, Physical Configuration & Scale, Dataset, Engagement Mode, and Spatial Experience. We provide an illustrated report of this design exploration, highlighting how the intersections of these components leads to the manifestation of new design ideas and nourishes the design process.

Design Process Pipeline in Visualization

The visualization community has described data visualization as a pipeline that transforms raw data into an image through a series of successive transformations. Several versions of this pipeline have been proposed over the years (4;5) and refined (6;7). This pipeline, however, falls short on at least three aspects relevant to our work. First, it does not directly apply to physicalization (8). Second, it does not capture well approaches that include forming and communicating a narrative—better captured by other processes such as those introduced by Kosara et al. (9) and Lee et al. (10). Third, it provides a limited view of interaction with visualization (11).

The infovis pipeline was adapted to physicalization by adding a 'rendering' step (8) where the visualization is transformed into a physical presentation—to then be perceived and understood by viewers. Willett et al. (12) further added to this model the notion of physical referent—the actual object or space to which data pertains. Interacting with the physical referent can alter the data, therefore multiple physical referents and presentations can be combined and interpreted collectively. These models simplify the progression through, and relations between, the different components, with a relatively linear approach that excludes interactive representations.

In sum, although processes exist that consider one or several options of representation, physicalization, interaction, and storytelling, none captures appropriately all these aspects simultaneously. When so many design dimensions are to be considered, taking a design thinking approach (2;13) is necessary.

Design Components: Fixed and Free

Our approach to design is exploratory, not confined to a specific sequence or even initially dictated by a dataset. Central to the design process are the 'fixed' and 'free' design components.

The **fixed components** establish the fundamental guidelines for the project and inform the design process, acting as the starting points for exploration. These elements, while fixed, provide the necessary structure to allow for flexibility and creativity in how the design evolves, ensuring a balance between guidance and creativity. There are four fixed design components in this project: the project's Role as a data installation, the Context as an exhibition, the Audience as scholars and practitioners in visualization and related areas, and the VISAP Theme of diversity. These elements together create a setting that encourages creative and open exploration of the design components. This approach helps the project connect well with its intended audience and stay true to the conference's theme of diversity.

The **free components** encompass the components that provide scope for creative exploration. There are seven free design components in this project: Interaction Mode, Technology, Data Representation, Physical Configuration & Scale, Dataset, Engagement Mode, and Spatial Experience.

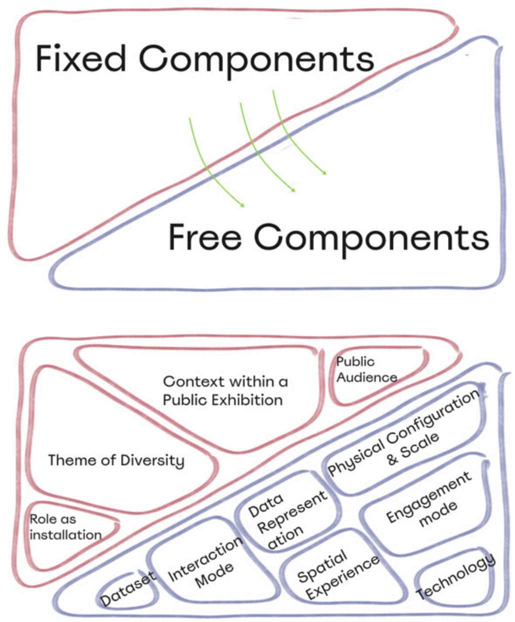


Figure 1: Building upon the foundation set by the fixed components, we start a dynamic exploration of the free components.

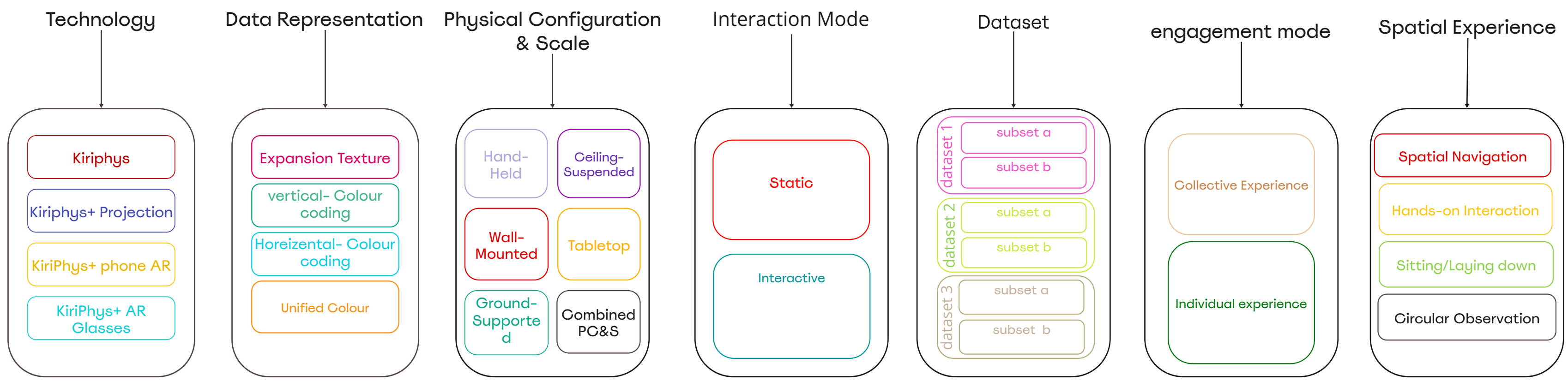


Figure 2: Summary of Design Component Exploration- This diagram outlines the explored ideas within each design component.

Design Component Exploration Summary

The explored ideas within each component are summarized in Figure 2. For the Technology component, we explored various techniques that are compatible with KiriPhys (which we explain in detail in the following section), for instance combining it with sculptural elements or integrating Augmented Reality. Data Representation ideation involved various ways of encoding data in the installation, both visually and physically, using the expansion texture and tactile qualities of KiriPhys as well as more conventional methods like color coding. For Physical Configuration & Scale, we explored the spatial setup and size of the installation, ranging from small handheld pieces to large ceiling-suspended or wall-mounted installations. For Interaction Mode, we experimented with the type of engagement, whether it involves static elements or interactive experiences that allow direct manipulation or embodied interaction. For Dataset, we explored different data options and drew different subsets and refinements within a single choice. Engagement Mode captures how viewers will engage with the installation, ranging from collec-tive group interactions to individual personal engage-ments. Spatial Experience examines the different physical interactions viewer can have with the installa-tion, such as spatial navigation or hands-on interaction.

KiriPhys

Kirigami Physicalization, or KiriPhys (1), is an approach to data physicalization that is inspired by the traditional Japanese art of paper cutting, Kirigami. KiriPhys enables the transformation of 2D planes into 3D structures by applying cuts with precise patterns on paper, offering an inherently flexible, artistic, and interactive way to represent data. We chose KiriPhys as the core technique for our design exploration because it provides an extensive design space in terms of data representation, form, scale, and material choices. It is particularly compelling for its ability to facilitate open exploration and ideation with fewer limitations imposed by the enabling technology.

Furthermore, the versatility of KiriPhys allows for integration with other technologies such as augmented reality (AR), unlocking new types of data experiences. The technique's adaptability extends to the use of accessible and inexpensive materials like paper and fabric, enabling us to push the boundaries of tra-ditional data physicalization practices and explore in-novative design possibilities.

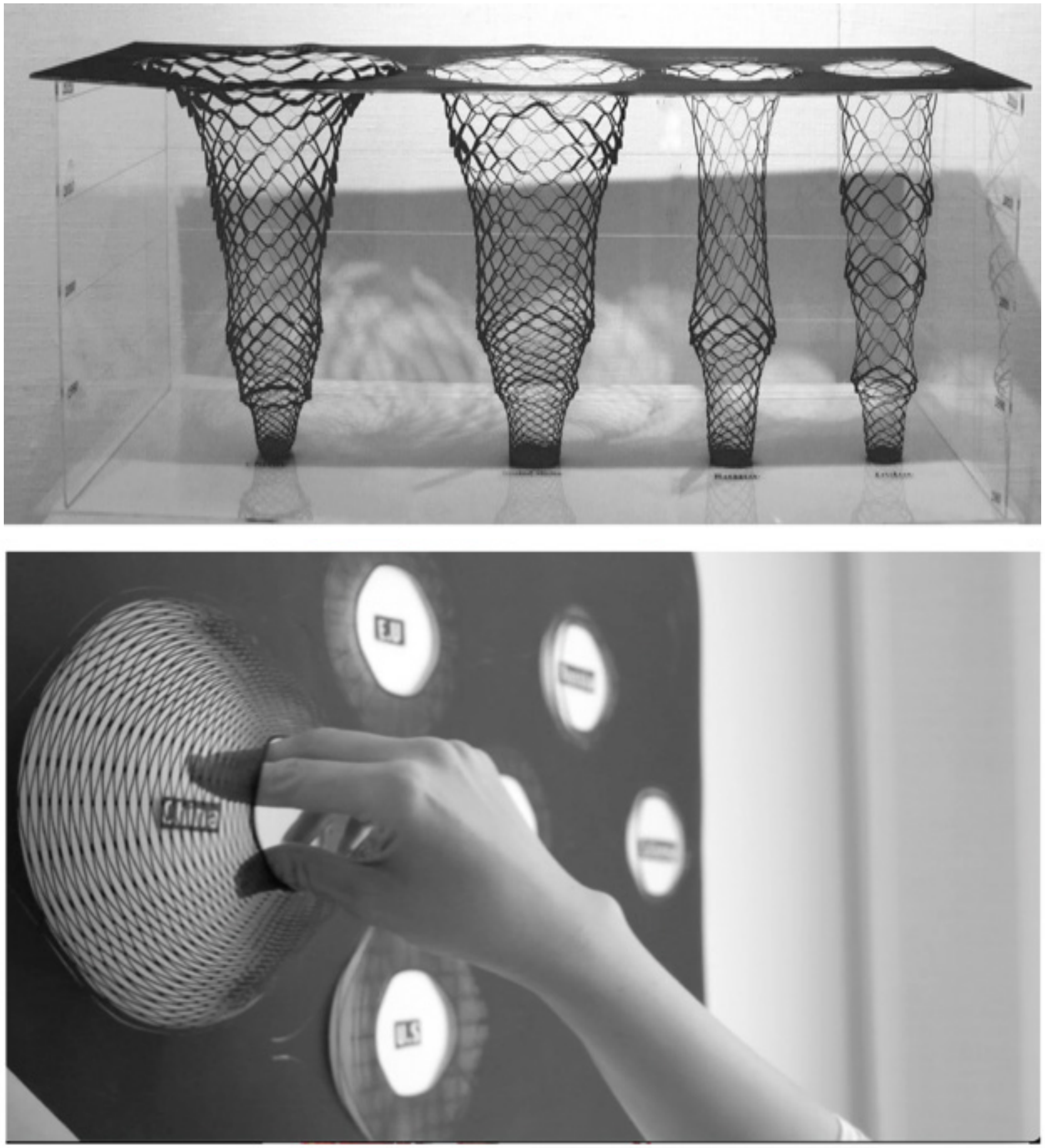


Figure 3: Some KiriPhys example to showcase the expandability of cat patterns

Design Exploration Diagram: Extended Version

Figure 4 is the extended version of the design exploration diagram. It provides a visual representation of our iterative and exploratory design process. It shows the continuous, dynamic, and non-hierarchical exploration of the seven core design components. As new ideas and designs emerge at the intersections of these components, the diagram highlights these overlaps with colored areas, and the sketches illustrate the concepts born from these intersections.

In this section, we zoom in on different parts of the extended design diagram to illustrate the intricacies of our design process. While the extended diagram illustrates the dynamic and non-hierarchical nature of our design exploration, the written explanation might appear sequential. This is simply a limitation of written text. In addition, while we discuss each segment of the extended diagram separately for clarity, we stress that these components are not isolated. Each part of the diagram is interconnected, reflecting a unified and holistic approach where every element interacts with and influences the others on the same level.

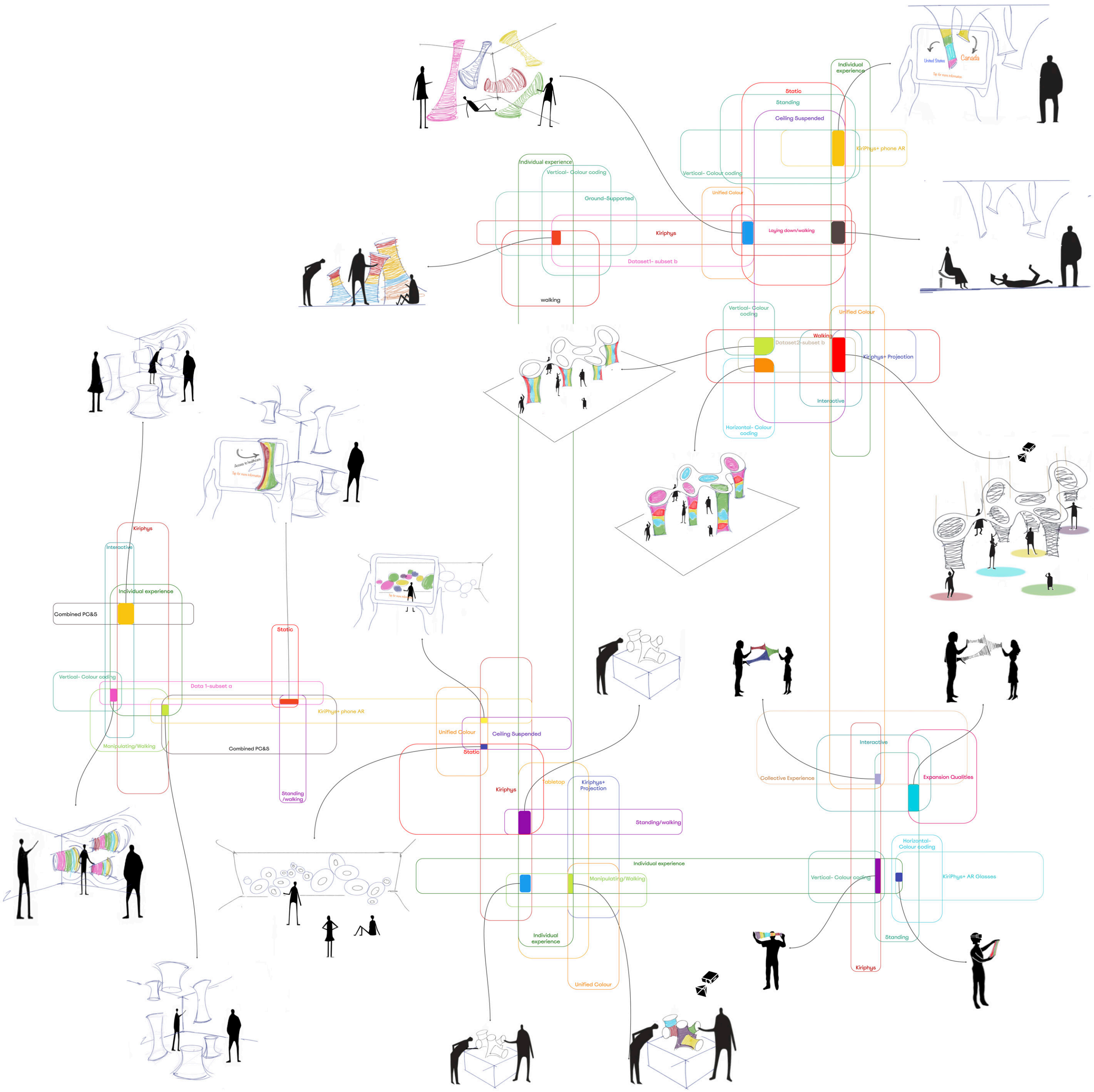


Figure 4: Design Exploration Diagram (extended version)

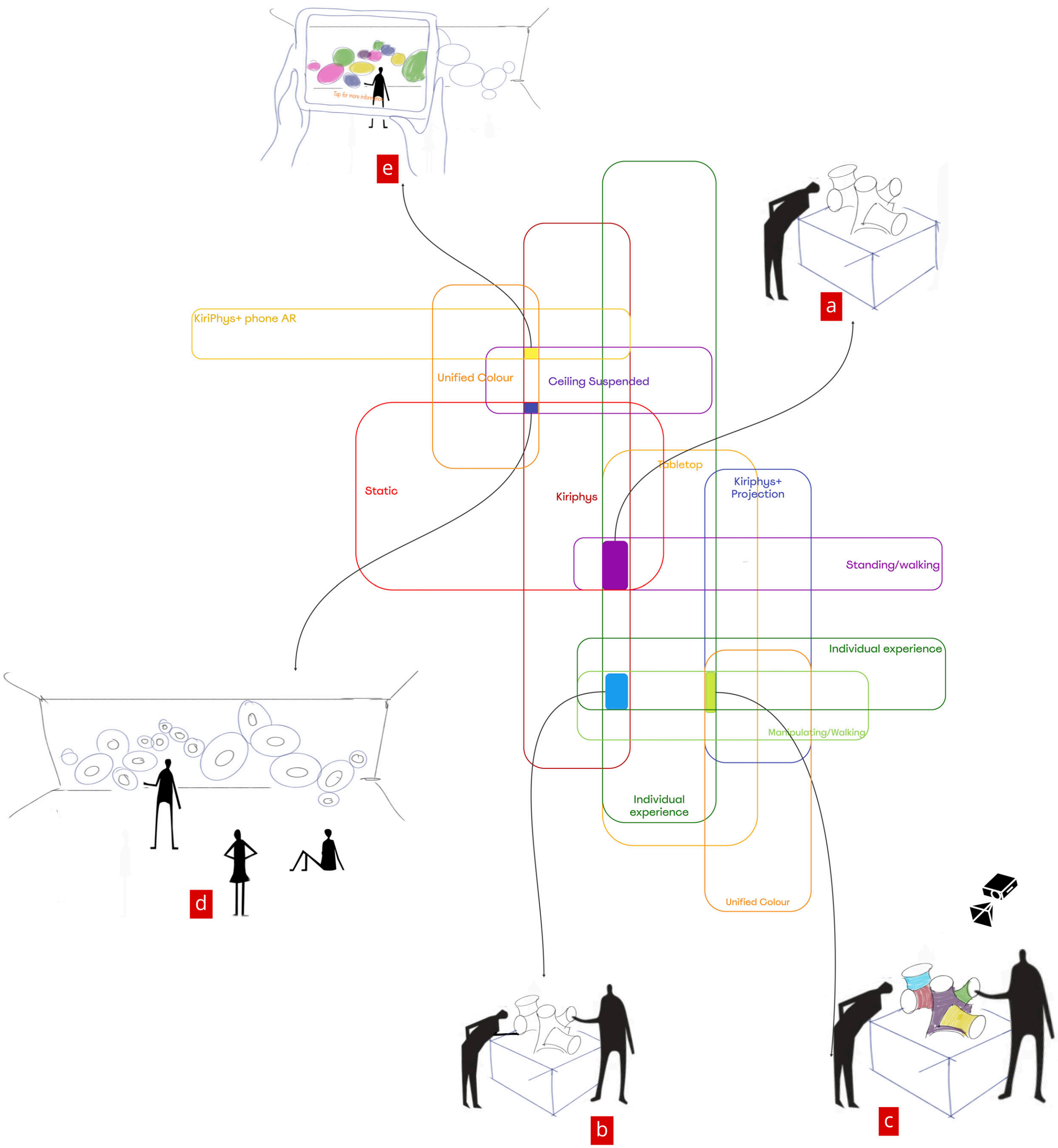


Figure 5: Design Exploration Diagram Zoom 1

Design Exploration Diagram Zoom 1

Here we detail the bottom-middle part of the design exploration diagram shown in Figure 2 (see Figure 5). This part shows our exploration of the design space initiated with tabletop data art pieces. We envisioned visitors navigating the space (Spatial Experience) and their possible interaction with the installation (Interaction Mode) and the possible technologies that can shape their data discovery. This inspired experimentation with various interaction modes, such as static (see Figure 5-a) and interactive sculptures (see Figure 5-b), sparking some design concepts from their overlap with other explored components. While exploring different datasets, we used projection (Technology) and mapped data to colors (Data Representation) projected onto the sculpture (see Figure 5-c).

With the concept of data sculpture in mind, new ideas with different scales and physical configurations began to take shape (see Figure 5-d). As we scaled up the pieces, we experimented with augmented reality (AR) to experiment how new interactions could influence engagement with the piece (see Figure 5-e).

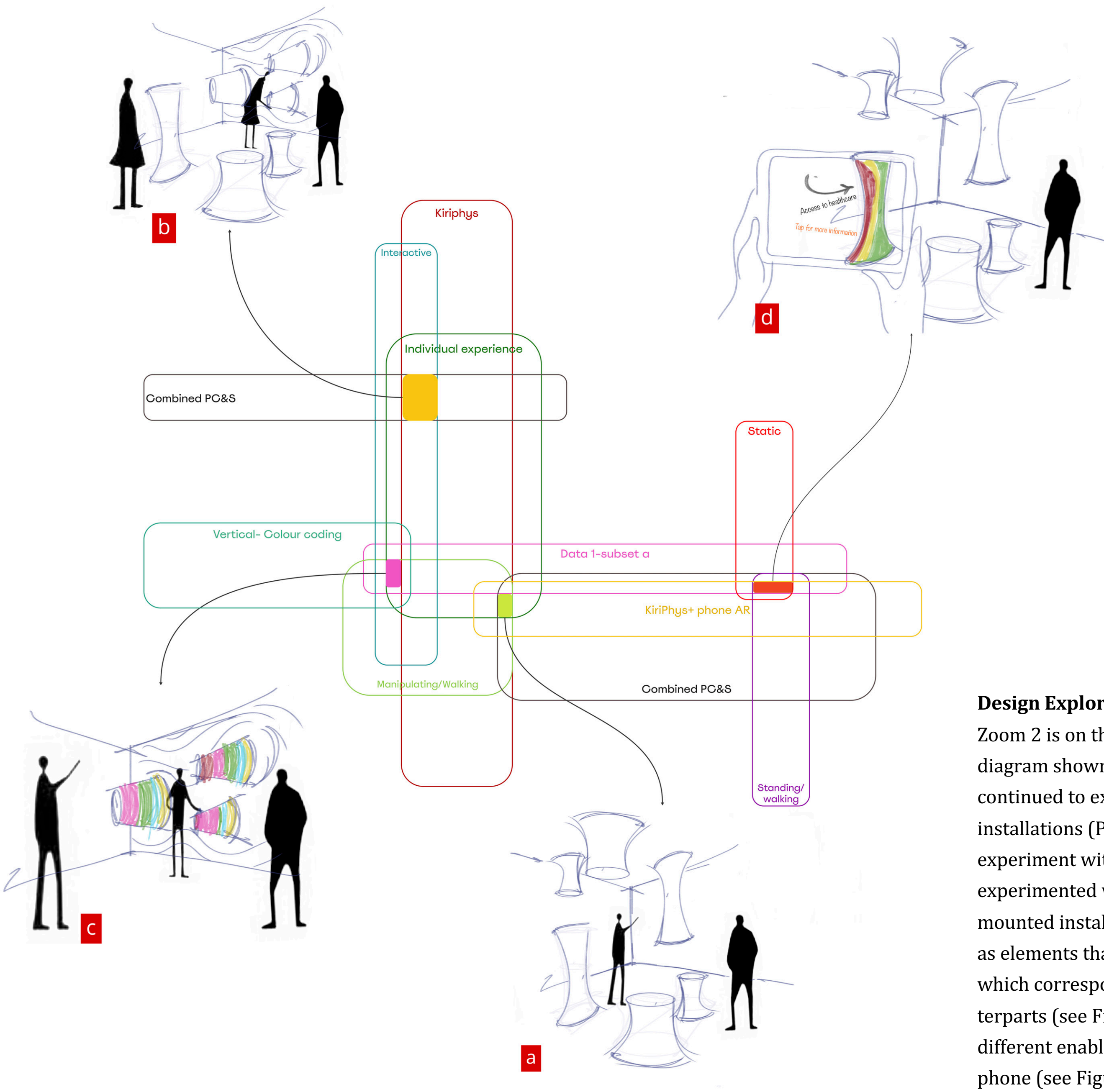


Figure 6: Design Exploration Diagram Zoom 2

Design Exploration Diagram Zoom 2

Zoom 2 is on the left part of the design exploration diagram shown in Figure 2 (see Figure 6). Here, we continued to explore the possibilities of large-sized installations (Physical Configuration and Scale) to experiment with embodied spatial experiences. We experimented with ground-supported and wall-mounted installations (see Figure 6-b and c) as well as elements that are suspended from the ceiling, which correspond to their ground-supported counterparts (see Figure 6-a). In parallel, we investigated different enabling technologies such as AR on a phone (see Figure 6-d).

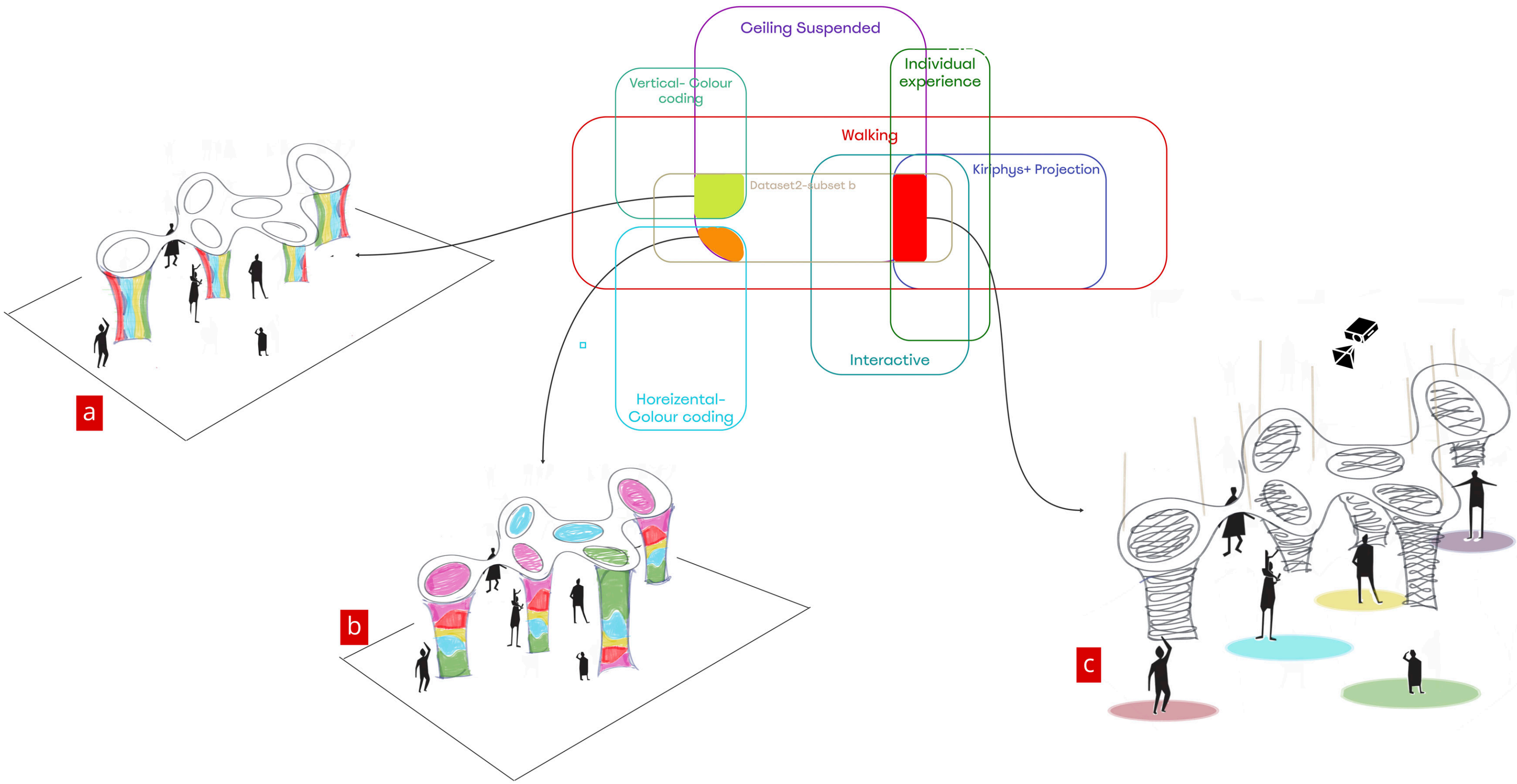


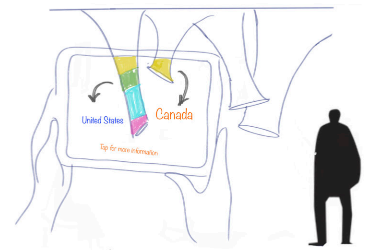
Figure 7: Design Exploration Diagram Zoom 3

Design Exploration Diagram Zoom 3
Zoom 3 is on the middle-right part of the design exploration diagram shown in Figure 2 (see Figure 7). Here, we looked at the interplay between Data Representation, Physical Configuration, and Spatial Experience. We explored the integration of vertical (see Figure 7-a) and horizontal (see Figure 7-b) color coding within ceiling-suspended installations, experimenting with AR-infused KiriPhys using projectors (see Figure 7-c). By manipulating how the same data subset is projected and mapped in the physical space, we aim to influence visitor behavior and enhance their data experience. These design ideas encourage viewers to navigate through the data by walking, standing, and viewing the installation from different distances and perspectives.

Design Exploration Diagram Zoom 4

Zoom 4 is on the top-right part of the design exploration diagram shown in Figure 2 (see Figure 8). It highlights the variety of spatial experiences we considered to engage people with the art installation by intersecting Spatial Experiences, Data Representation, Technology, and Physical Configurations.

One such idea is to engage people in walking with their devices and in interacting with the piece through AR overlays (see Figure 8-a). Another idea features suspending the installation from the ceiling (Physical Configuration and Scale), which invites visitors to lie down (Spatial Experience) and view the artwork from a unique perspective, promoting a prolonged and memorable experience (see Figure 8-b). Another idea shows the integration of large-scale installations connecting to different architectural elements, each representing one data aspect (Data Mapping) (see Figure 8-d). This design prompts visi-tors to wander and explore different parts of the in-stallation. Each viewpoint offers new insights, turning the exploration into a maze-like journey of discovery.



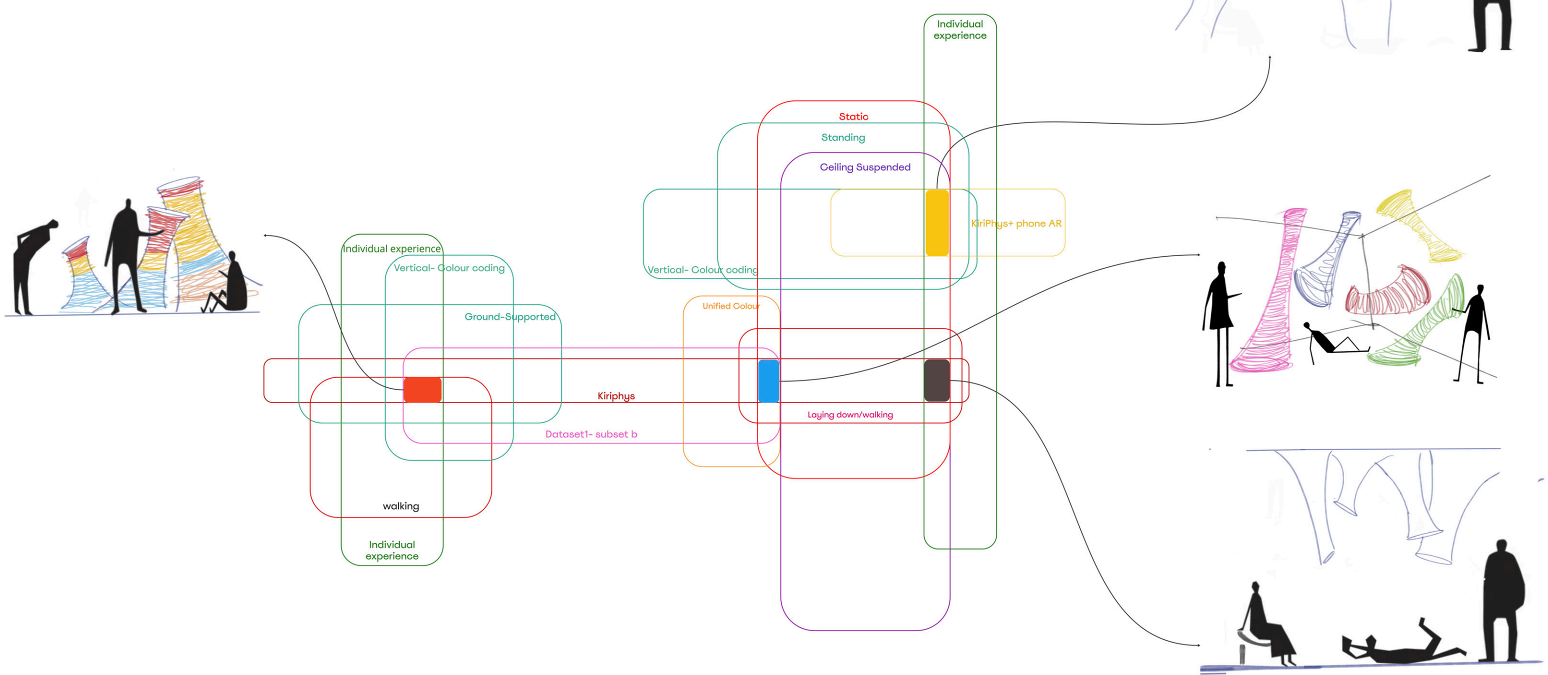


Figure 8: Design Exploration Diagram Zoom 4

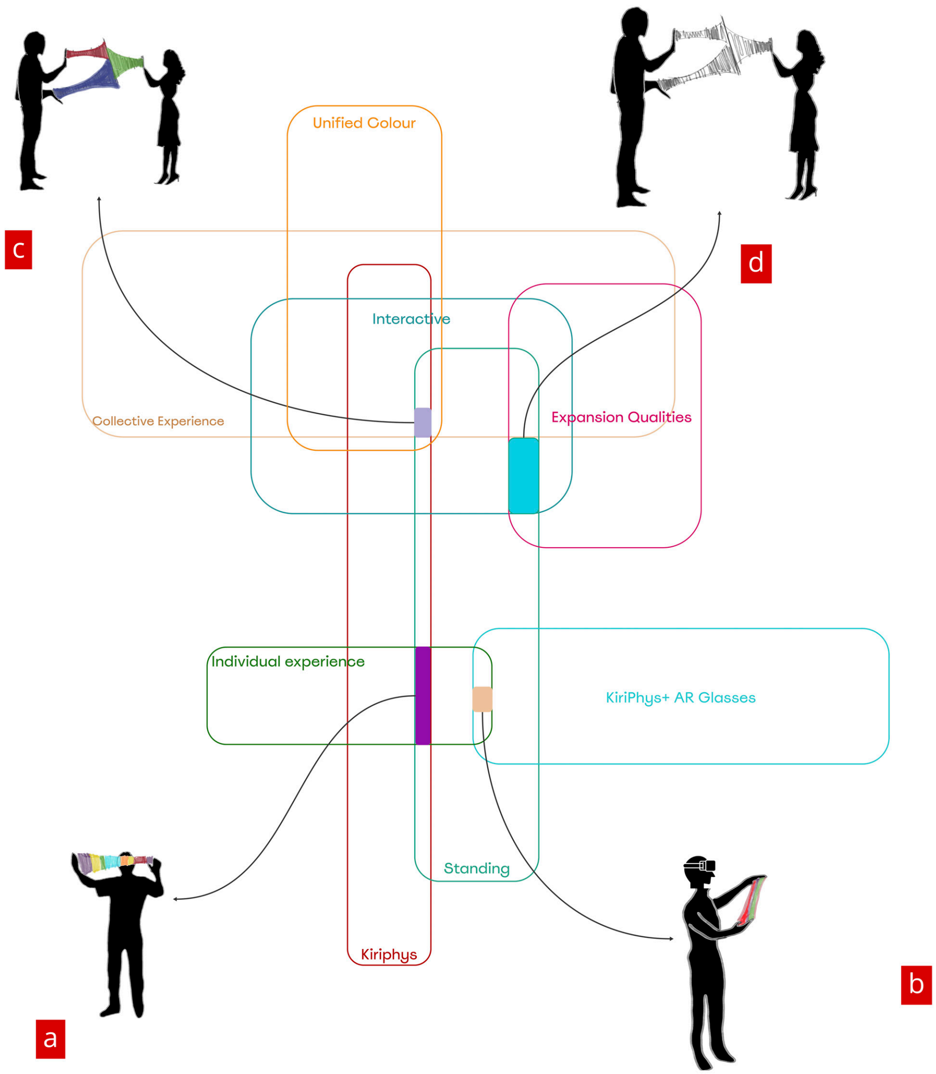


Figure 9: Design Exploration Diagram Zoom 5

Design Exploration Diagram Zoom 5

Zoom 5 is on the bottom-right part of the design exploration diagram shown in Figure 2 (see Figure 9). The ideas that emerged in this section are centered around the handheld scale, and while these experiences might appear similar at a glance, they offer profoundly different data experiences. These range from collaborative to solitary experiences, utilizing diverse visual and tactile exploration methods.

One emergent idea involves a collaborative interaction with the artwork, where participants can view and manipulate data overlays using AR glasses (see Figure 9-b). This approach fosters a communal data exploration experience, highlighting how digital enhancements can augment physical data representations.

Another concept that emerged during our exploration of representation techniques was tactile qualities such as texture and resistance of expansion (see Figure 9-d). These provide a different kind of experience, beyond the visual, by engaging users through the sense of touch, allowing them to 'feel' the data and perceive it through physical resistance and changes in the shape of the model.

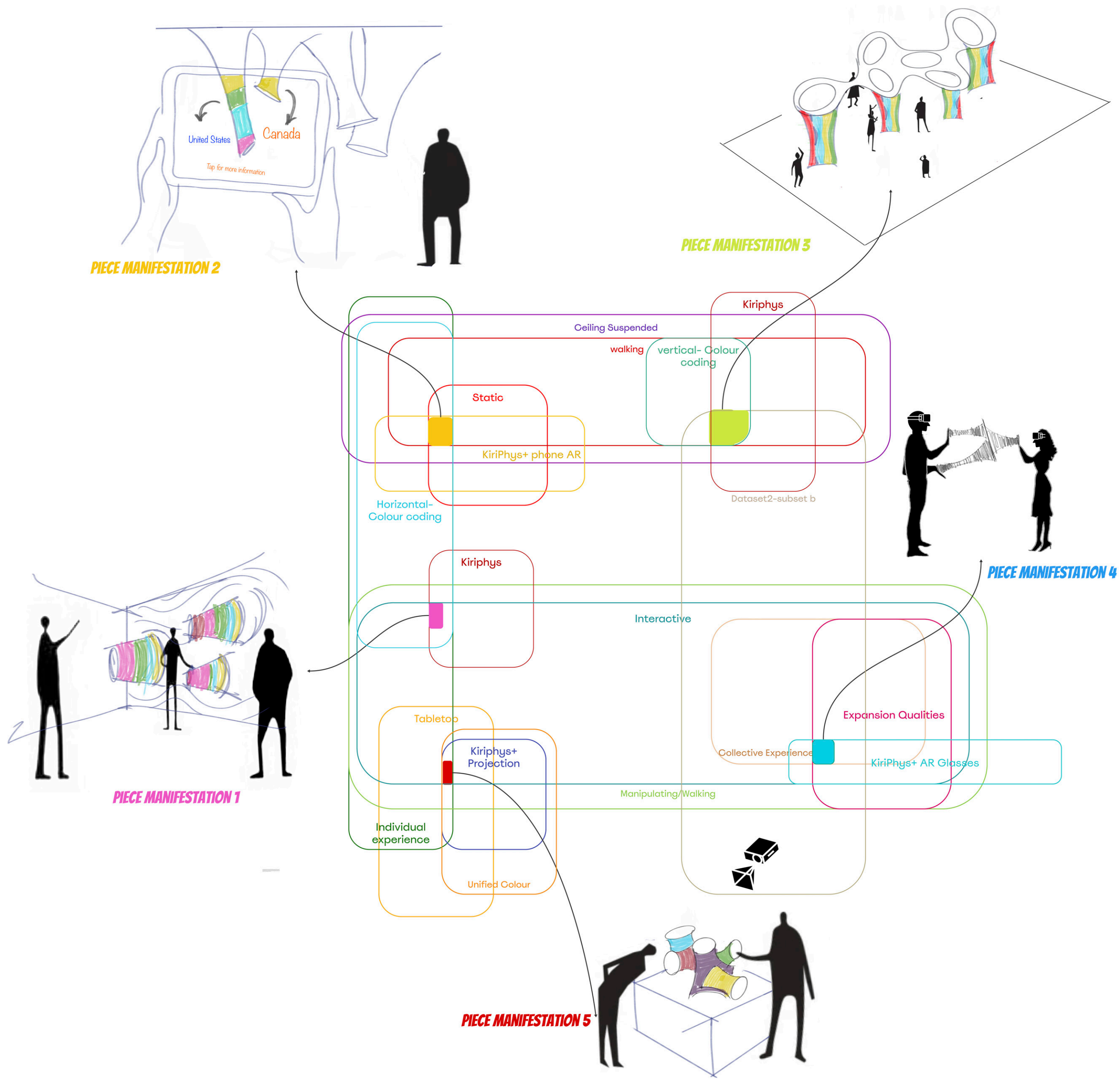
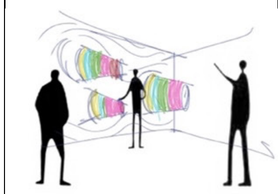
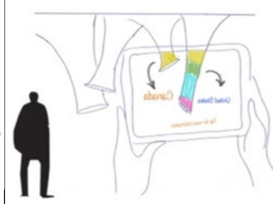
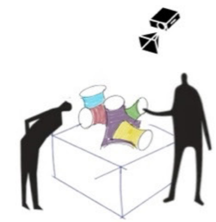


Figure 10: The five piece manifestations that emerged at the intersections of the seven design components.

Table 1: The five piece manifestations we considered for the final design, described in terms of the seven design components we explored.

Piece Manifestation					
Data set	Literacy Rate world-wild	Access to Healthcare	Refugee deaths in Routes	Literacy Rate	Suicide Demographic in North America
Technology	Kiriphys	KiriPhys+ Phone AR	Kiriphys	KiriPhys+ AR Glasses	Kiriphys+ Projection
Physical Configuration and Scale	Wall-Mounted	Ceiling-Suspended	Ceiling-Suspended	Hand-Held	Tabletop
Data Representation	Horizontal- Colour coding	Horizontal- Colour coding	Vertical- Colour coding	Expansion Texture	Unified Colour
Spatial Experience	Spatial Navigation	walking and Phone Interaction	Spatial Navigation	Circular Observation	Circular Observation
Interaction Mode	Interactive	Static	Interactive	Interactive	Static
Engagement Mode	Individual Experience	Individual Experience	Individual Experience	Collective Experience	Individual Experience

Design Exploration Diagram: Five Piece Manifestations Emerged

In our exploration, we navigated through a breadth of design ideas, each emerging from the exploration of various design components. This phase illuminated the rich potential of integrating design components, showcasing a spectrum of possibilities.

The compacted version of the diagram, shown in Figure 10, distills five piece manifestations that together represent a coherent synthesis that emerged at the intersection of all seven design components. These manifestations are not just combinations but integrative results that highlight how the exploration of diverse elements—ranging from Data Representation and Interaction Modes to Technology and Scale—converge to form unique installation ideas. Table 1 summarizes the characteristics of each piece manifestation in terms of their properties with respect to the seven design components we explored.

Table 2: Selection criteria for final design installation

Criteria	Description	Reasons for selecting the Third Design
Data Significance	Impactfulness, uniqueness, and alignment with the conference theme.	The data on refugees is unique and highly impactful, exploring a critical global issue that has not been visualized for public extensively.
Data Representation	Representing several different data aspects in a clear engaging way	The representation encompasses different important factors, providing a rich view of the data.
Technology Feasibility	Feasibility of implementing the required technology, including the availability and accessibility of the necessary equipment and tools.	The needed technology, Solely KiriPhys, is accessible making it feasible within the project timeline and resources.
Time and Resources	Time and resources needed to develop and install each design, prioritizing those that can be realistically completed within the given constraints.	The project can be realistically completed within the given constraints.
Scale and Physical Configuration	Assessed for visibility and visual engagement, ensuring the installation encourages exploration.	The large, ceiling-suspended configuration ensures high visibility and encourages spatial navigation, making the experience immersive and engaging for visitors.
Spatial Experience and Interaction Preference	Taken into account to enhance the overall engagement.	The design provides an engaging spatial experience that enhances visitor interaction.

From Five Piece Manifestations to the Final Installation

We selected the final design by comparing the five-piece manifestations based on the criteria laid out in Table 2. We selected the third design from Table 1 because we assessed that i) it effectively communicates important data on refugees, ii) it engages the audience through spatial navigation, and iii) it creates a memorable and impactful experience. This decision reflects careful consideration of the richness of data, impactfulness, uniqueness, alignment with the conference theme, and practical aspects of implementation.

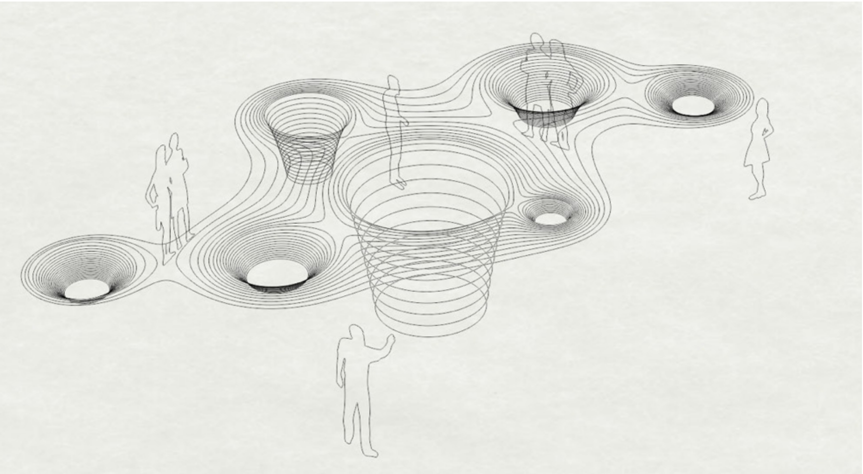


Figure 11: Schematic diagrammatic views of the installation

Conclusion

This pictorial explains our non-hierarchical, exploratory design process that led to the creation of the artwork "Shredded Lives: A Decade of Migrant Loss." By identifying and systematically exploring seven design components, we aimed to exhaust all possibilities to arrive at rich and impactful alternatives. The process involved iterative exploration and dynamic interactions between technology, data representation, physical configuration, and spatial experience. The chosen design, featuring a large ceiling-suspended installation that engages visitors in spatial navigation and presents critical data on refugees, exemplifies the effectiveness of this approach. This design process, guided by the seven design components we identified, is tailored specifically for this project and may be altered or adjusted for future installations to suit different themes or contexts.

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