Lake Constance

an interactive exhibition

HfG Schwäbisch Gmünd
IG2 Interactive Communication Systems
Documentation

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Introduction

The core objective of the Interactive Communication Systems course was the design and development of an interactive application was made for public spaces, such as exhibitions, museums, or trade fairs. The primary challenge was to take a specific field of knowledge and translate it into an experience that is both understandable and engaging for a broad audience. Rather than just presenting static data, the goal was to create a system where users can „experience“ information through interaction. This required a deep exploration of how physical objects and digital layers can merge. By focusing on intuitive usability and high visual quality, we aimed to bridge the gap between complex regional data and an immersive, multi-sensory journey.

Topic Selection

Topic Selection

At the beginning of our creative process, we evaluated two potential core subjects for our interactive application: **Human Organs** and **Lakes and Groundwater**. After extensive group discussions, we decided to pursue the latter.

The **primary reason** for this choice was the thematic versatility that a lake ecosystem offers. While a topic like human organs quickly becomes very specific and technical, a lake allows us to integrate a vast array of diverse sub-themes.

This variety ensures that the exhibition remains engaging and accessible to a much broader audience, catering to different interests and age groups.

The Significance of Lake Constance
Once the general field of „Lakes and Groundwater“ was established, we chose to focus specifically on Lake Constance. As Germany‘s largest lake, it is not only a geographical highlight but also a highly relevant living and economic space. It serves as one of Central Europe‘s most popular holiday destinations while simultaneously acting as a vital drinking water reservoir for millions of people.

Beyond its regional importance, our group also has a personal connection to the lake. Many of us have spent vacations there, and some of us even get our daily drinking water from Lake Constance. This personal link made the project very interesting for us and makes it an ideal subject for an interactive exhibition.



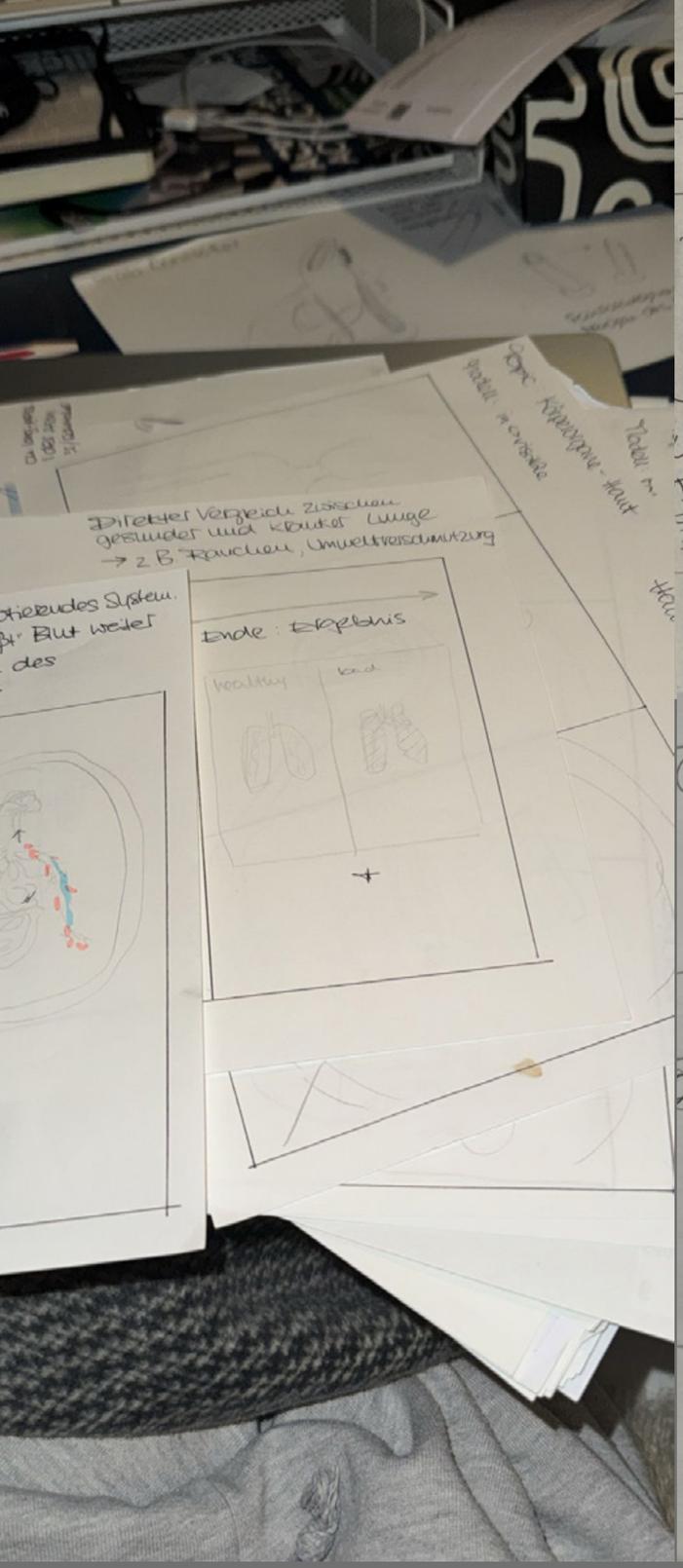
Exhibition Context

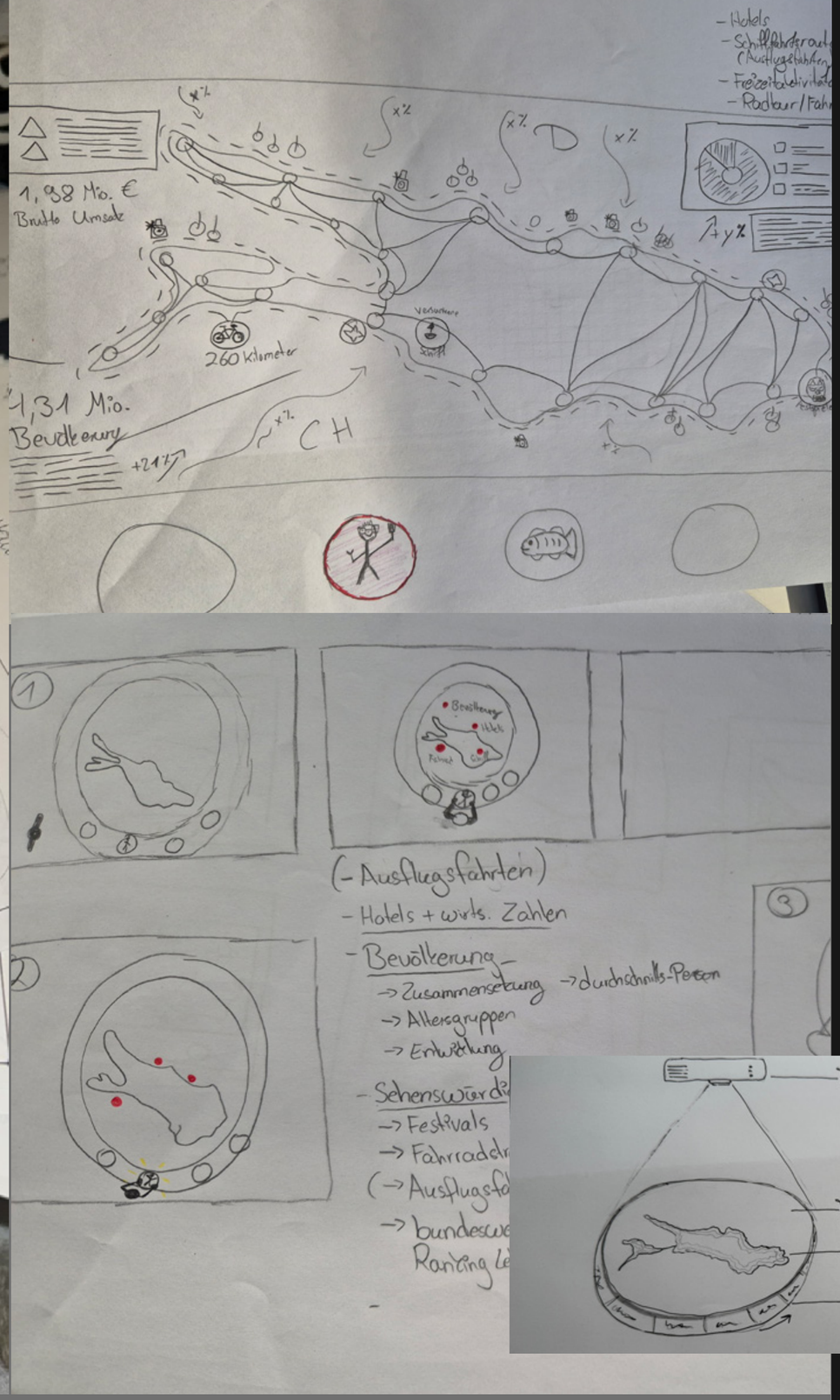
Exhibition Context



Our project is designed for a museum setting, specifically for institutions located near Lake Constance. It serves as an interactive installation that allows visitors to explore the lake's diverse characteristics in a tactile and visual way. The application is intended for a broad audience, encompassing all age groups ranging from local school children to international tourists. By presenting information through intuitive interactions, we ensure that the content is accessible for students as an educational tool, while also being engaging for travelers who want to learn more about the significance and beauty of the region. Because the installation relies on high-quality projections to display its content, the exhibition space needs to be darkened. A controlled lighting environment is essential to ensure that the colors and detailed animations stand out with high contrast. This ensures that the visual clarity of the information is maintained, providing an immersive experience for every visitor regardless of their prior knowledge of the subject.

First Ideas





First Ideas

The first phase of our design process focused on gathering a wide range of ideas through individual sketching. Every group member created several visual concepts to brainstorm different ways of presenting the lake's information and structuring the user interaction.

Following this, we exchanged and discussed these sketches as a team to identify the most promising approaches and evaluate their feasibility.

This iterative brainstorming process resulted in a large variety of conceptual directions, ranging from different table shapes to various methods of digital and physical interaction. By analyzing and comparing these early ideas, we were able to narrow down our focus and define the core requirements for our final exhibition object.

Thematic focal points & research

Thematic focal points

Once we had decided on Lake Constance as our subject, we evaluated which thematic areas offered the greatest potential for an interactive exhibition. Our goal was to find a balance between ecological, social, and political aspects. This resulted in our five core categories:



Drinking Water Supply: The essential importance of the lake as a source of life.



Politics: Cross-border cooperation between the neighboring countries.



Life and Tourism: The lake as a dynamic recreational and residential space.



Shipping: Historical and modern transport routes, as well as water sports on the lake.



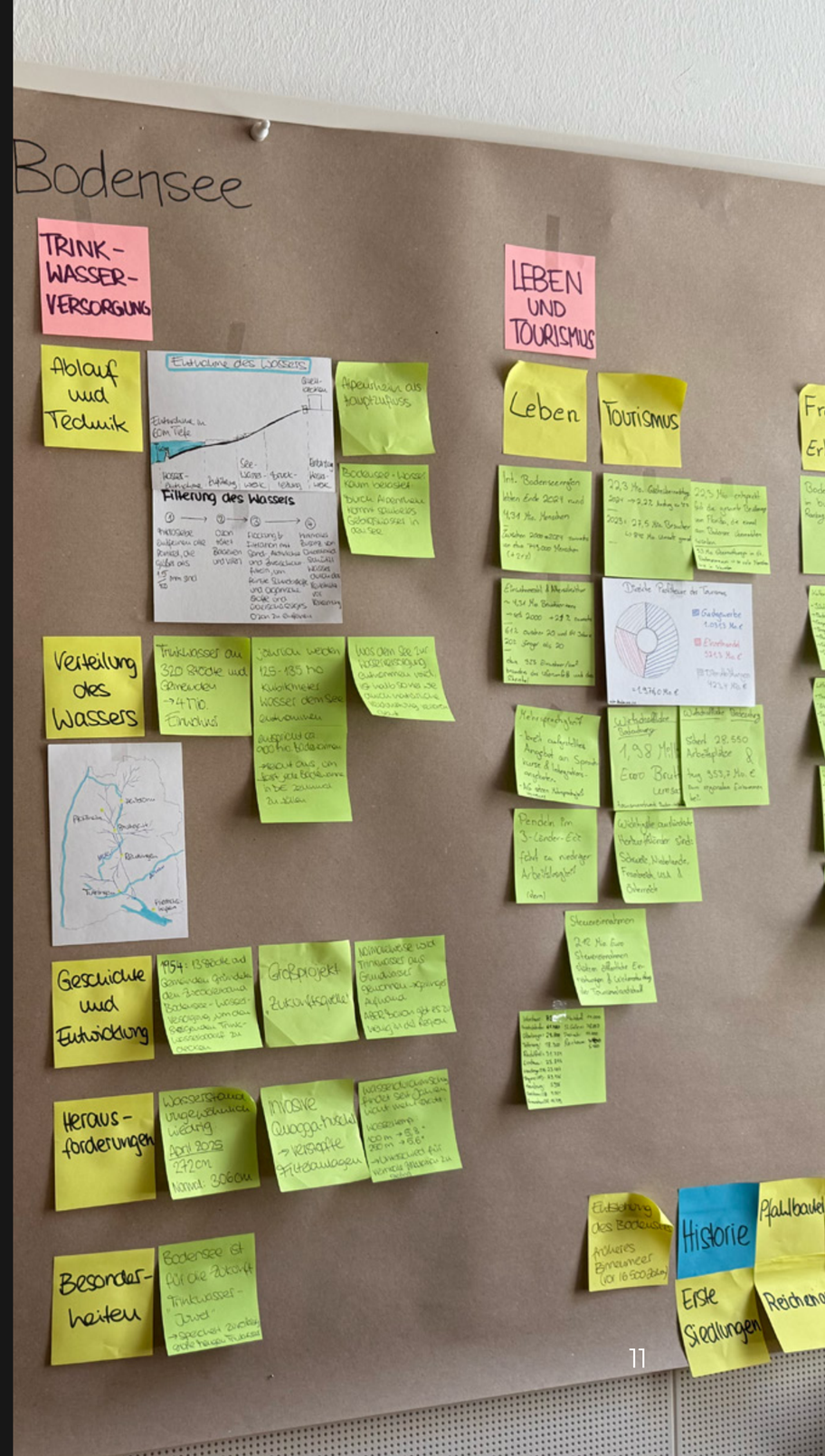
Biodiversity: The flora and fauna of the ecosystem, which are worth protecting.

... & research

To achieve the greatest possible depth of information, we divided the research within the team. We initially structured our findings analogously using sticky notes to visualize the connections between the complex sub-topics. Despite the abundance of data collected, we decided to specifically focus on Drinking Water Supply for the first functional prototype.

This decision was based on the unique relevance of the topic: as Europe‘s largest drinking water reservoir, Lake Constance supplies over four million people as far away as the Stuttgart area.

This vital connection between humans and nature makes the topic an ideal use case to demonstrate the strengths of our interactive tangibles and animations. Based on this in-depth research, we then began designing the graphics and preparing the editorial content.



Bodensee

SCHIFF-FAHRT

ARTEN-VIELFALT

Fisch-bestände

Tierarten Wasser & Land

invasive Arten

Algen

Alpenrhein als Kraftwerkskanal

TRINK-WASSER-VERSORGUNG

Ablauf und Technik

Verteilung des Wassers

Gewässer und Entwässerung

Heraus-forderungen

Besonder-heiten

LEBEN UND TOURISMUS

Leben

Tourismus

Freizeit & Erholung

Insel Mainau

Bregenzer Festspiele

Affenberg

POLITIK

Nutzung des Sees

3 Ländereck

politische Grenzsituation

Internationale Bodensee-konferenz (IBK)

Private Ufer-bebauung

Historie

Erste Siedlungen

Pfahlbauten

Reichenau

Entwicklung als Lebensraum

Landwirt-schaft

Apfelanbau

Weinanbau

Reichenau

Industrie

Zeppelin

ZF

Airbus

Bildungs-standort

Affenberg

First setup concepts

First setup concepts



Based on our initial brainstorming and sketches, we developed a primary vision for the exhibition object: a large, round interactive table. The decision to use a circular shape was driven by our goal to create a truly collaborative experience. Unlike a rectangular screen or a single-user terminal, a round table has no defined „front“ or „back.“ This allows visitors to stand anywhere around the perimeter, fostering social interaction and enabling multiple people to explore the lake together from different perspectives. To bring this vision to life, our first setup idea involved a projection-based system. A projector mounted above the table beams high-resolution information and graphics directly onto the surface. The core of this concept is interactivity: the table is not just a passive display, but a responsive interface. By interacting with the table‘s surface, users can trigger specific content and discover „hidden“ information about Lake Constance.

Display of the lake

Display of the lake

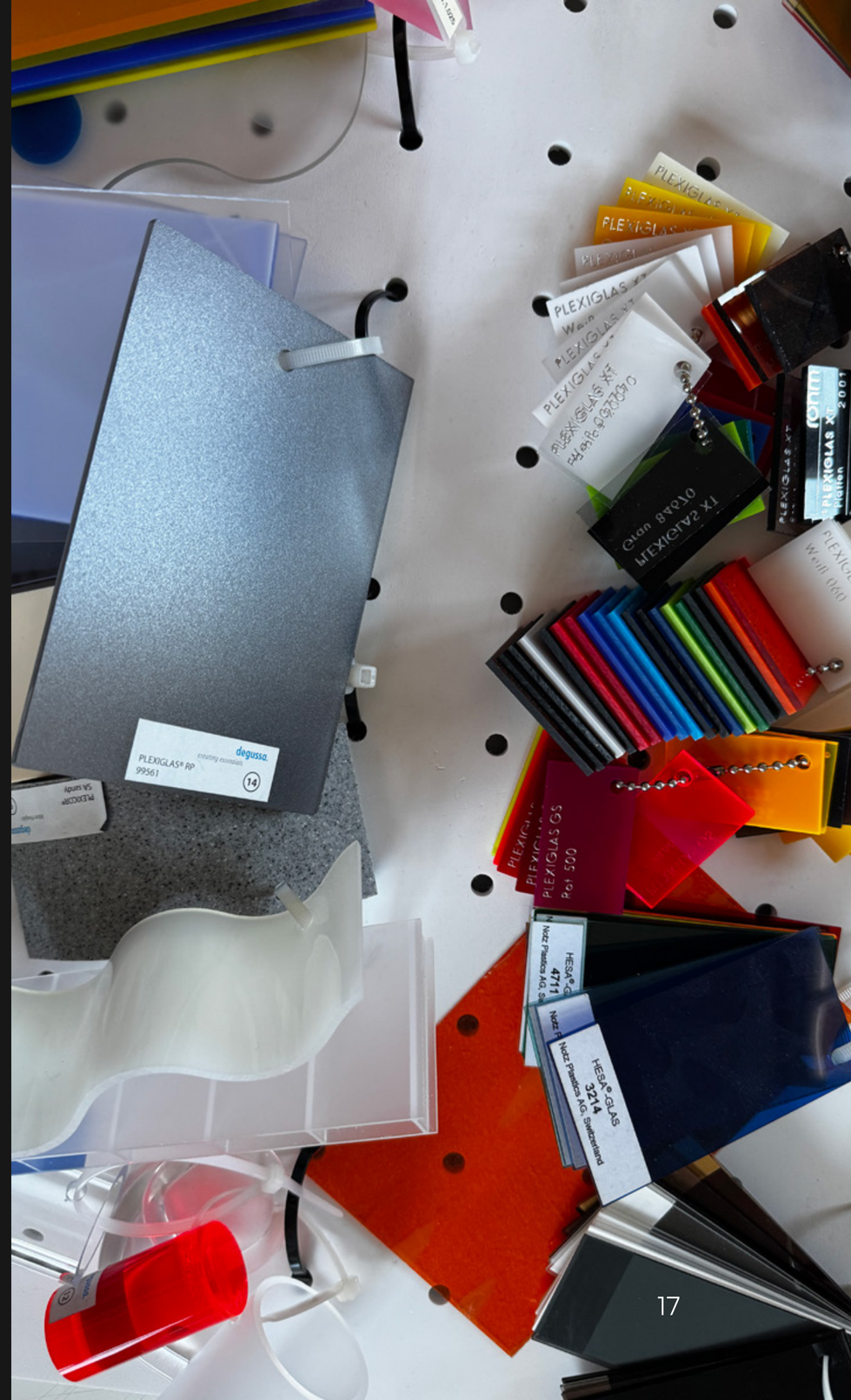
The 3D Topographical Model
The primary vision was to place a physical cutout of Lake Constance at the center of the table. Our initial concept involved a 3D wooden model representing the lake's topographical layers. While this physical approach was visually appealing, it would have not worked out. We realized that projecting animations onto staggered wooden layers from an overhead position would cause visual distortions and „breaks" in the imagery. This would have made it impossible to display clear animations on the lake surface.

Experiments with Frosted Glass
To address these anticipated distortion issues, we considered placing a layer of frosted acrylic glass over the wooden cutout to create a flat projection surface.

However, we concluded that the frosted glass would obscure the details of the wooden model so much that the complexity of building a physical 3D topography would lose its value. We then moved toward a hybrid idea: replacing the wooden model with a high-resolution display to show the topology digitally, while using frosted glass as a „water surface" for the overhead projections.

Physical Prototyping and Technical Challenges
To determine how these two layers would interact, we conducted several physical tests with the materials. These evaluations revealed a significant conflict between the visibility of the digital topology and the projected animations. We discovered that a specific distance between the display and the frosted glass was required to make the projection clearly visible; however, this gap caused the underlying topology to appear blurry and disconnected.

Conversely, reducing the distance to sharpen the view of the display caused the frosted surface to become too transparent, resulting in a loss of clarity for the projected animations.



Final Solution:
The Direct Display Approach
Another idea was to use a clear acrylic glass cover to keep the table surface flush and smooth. We quickly discarded this because the projectors caused intense reflections on the clear surface.

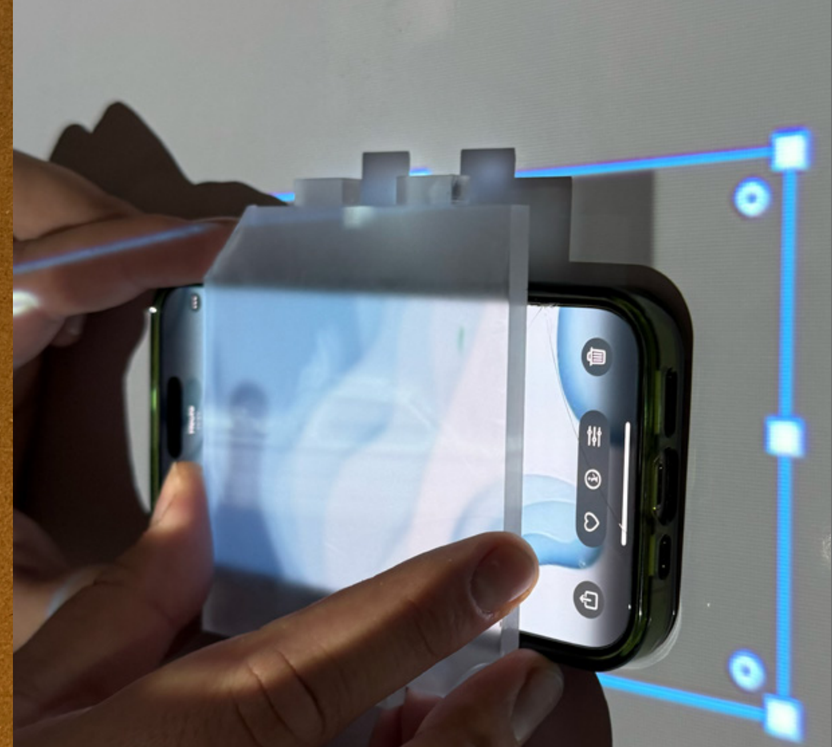
Ultimately, we decided to remove any additional layers and use the display directly. This proved to be the best solution for several reasons:

- **Clarity**: Both the digital topology and the overlaid animations are perfectly sharp and synchronized on a single plane.

- **Depth** Effect: Removing the top plate created a „sunken“ effect, adding a new level of visual depth to the table.

- **Luminosity**: The display provides its own light source from below, which makes the lake stand out vibrantly against the darkened exhibition space.

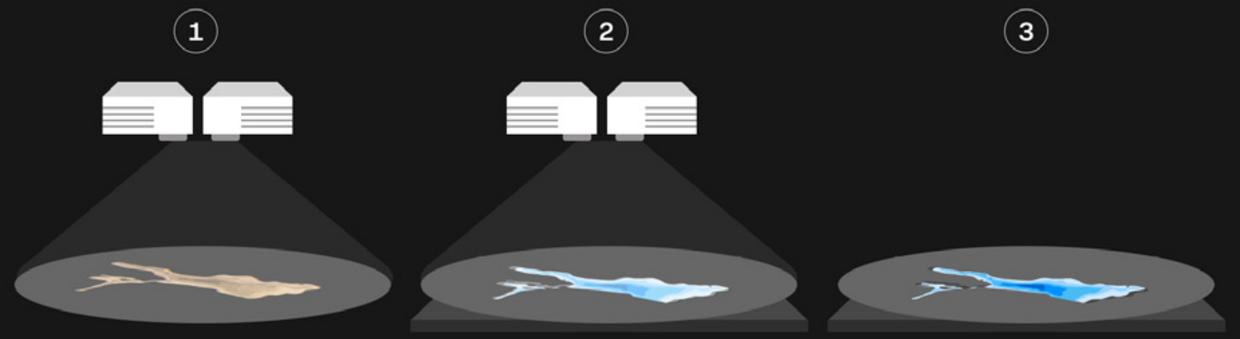






Interaction Design

Interaction Design



topology wooden model
frosted acrylic plate

digital topology model
frosted acrylic plate

digital topology model
animations on the display

Evolution of the display prototype from physical layers to the final digital solution

Evolution of the Interaction Design

During the development of the interaction model, we explored several ways to navigate through the five main themes. Our first idea was to use the rotation of the table as a switching mechanism, which felt intuitive given the circular shape. However, we quickly realized that a simple rotation was insufficient for the depth and complexity of the information we wanted to convey. Following this, we experimented with a more complex „flow“ system involving timed paths and moving elements. While dynamic, this approach felt too playful. This led us to our final concept.



Tangible Interaction
This concept utilizes Tangibles. In this context, Tangibles are physical objects that serve as the interface between the user and the digital content. Instead of using a mouse or a touch-screen, users interact with these physical objects to trigger specific information or animations. This makes the exploration of the lake's data a tactile experience, where the physical act of „placing" an object leads to a digital reaction. For our project, each of the five exhibition themes is represented by a unique physical tangible. When a user places a tangible on a designated spot on the table, it acts as a trigger for the corresponding digital layer. To make this interaction feel more authentic and high-quality, we integrated a magnetic „snap-to-grid" mechanism:

Haptic Feedback & User Experience:
When a user moves a tangible toward a drop zone, the magnetic pull causes the object to „snap" into the exact center.
This provides immediate physical confirmation that the interaction was successful and the information is about to be triggered. This physical „click" makes the system feel „real" and robust, creating a satisfying, tactile connection between the physical world and the digital animations.

Construction
& IT

Construction & IT

In order to build the table, we used a laser to cut two 4 mm thick wooden panels. These were given a round outer shape with a cutout of Lake Constance in the middle. We had to divide the tabletop in half to achieve a total diameter of 1.40 m, as the laser‘s working surface would not have been large enough for a component of this size.

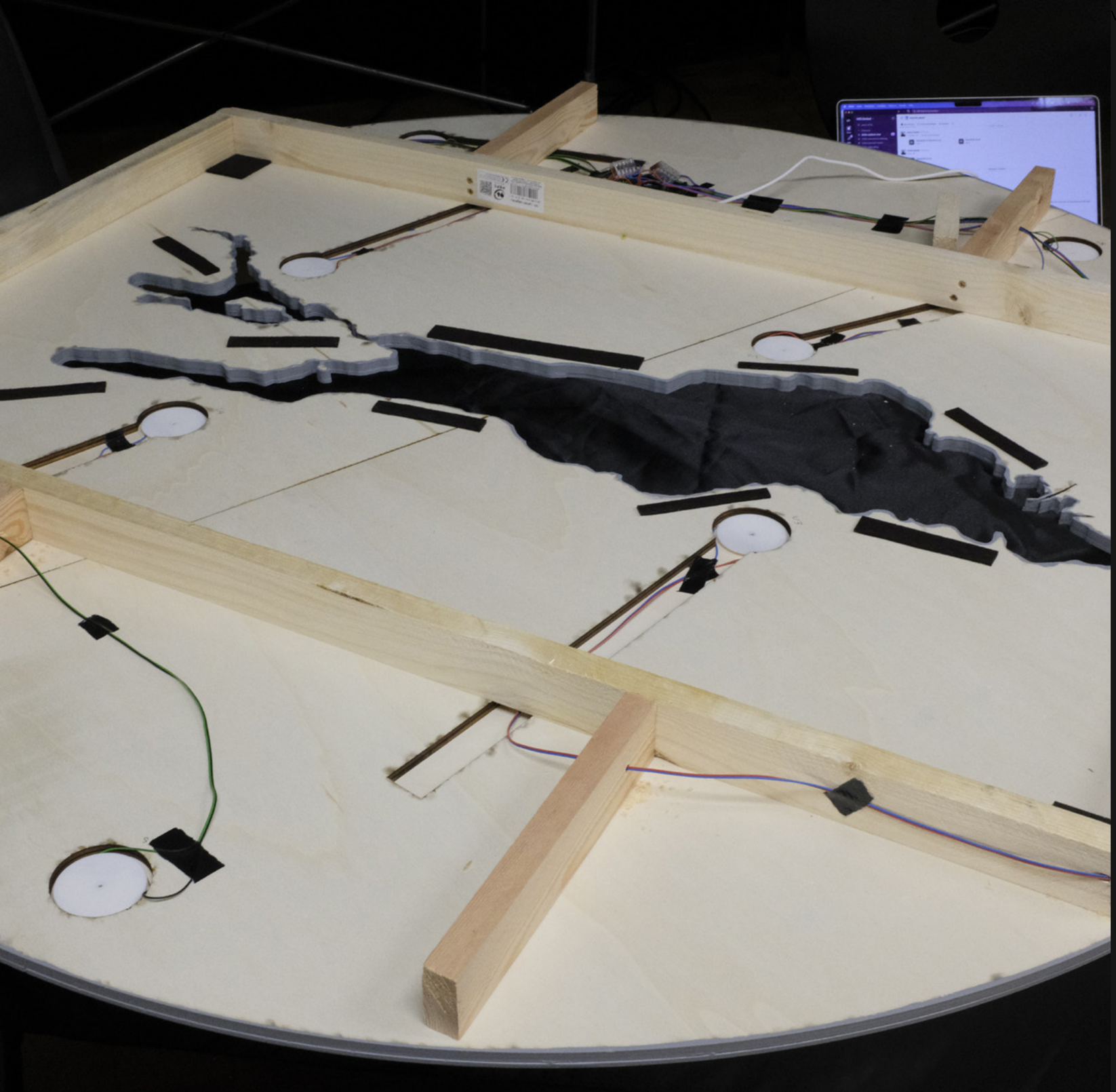
We cut a repeat of the layout from 8 mm-thick wooden panels using a laser, so that there is space for cables and sensors between the tabletop and the monitor. For this lower layer, however, we deliberately rotated the cut through the panels. This offset means that the cut edges of the upper and lower layers do not lie directly on top of each other. This helped us to increase stability and ensure that the edge on the top of the table remains as flat as possible.



first laser cut out on 4mm-thick wood panel



second laser cut out on 8mm-thick wood panel



The lower table tops were then screwed onto a wooden frame, which is designed to fit the monitor perfectly. Since the round panels protrude significantly beyond the monitor, there was a risk that the wood would bend or even break under load.

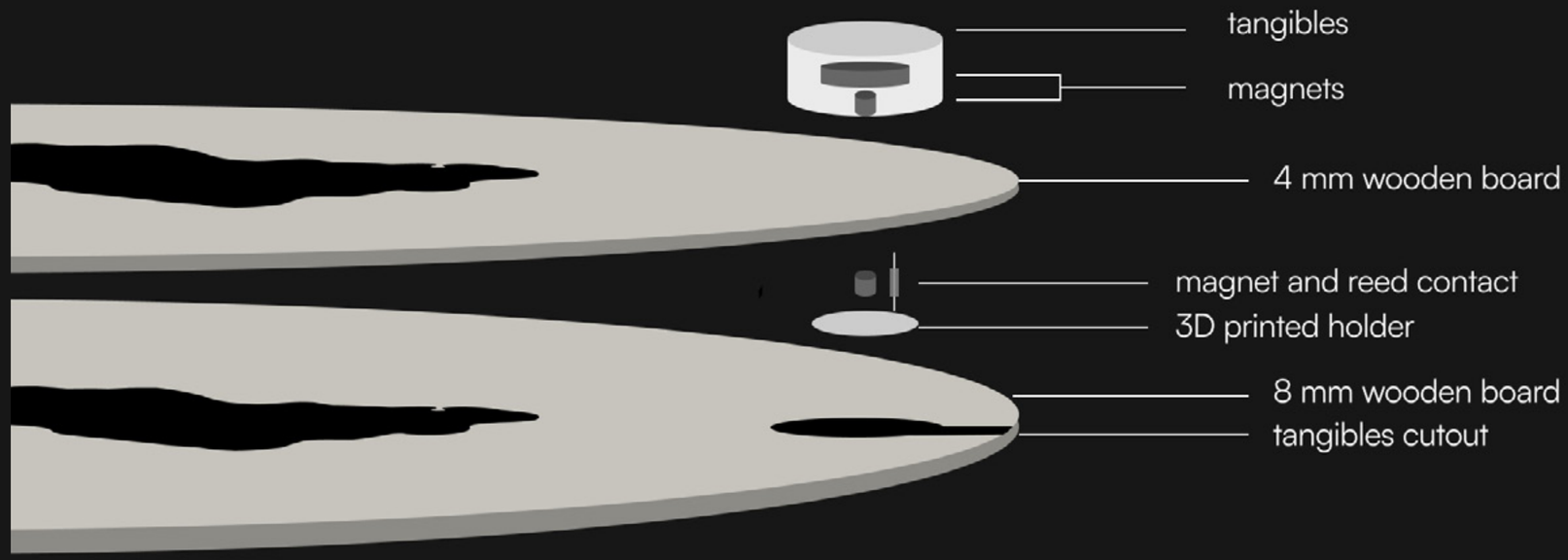
To prevent this, we attached additional supports to the wooden frame that protrude outward and stabilize the panel. The upper 4 mm-thick panels were finally glued onto the lower layer. This approach had the great advantage that no screws are visible on the finished top surface, creating a clean overall look. We finally painted the surface to achieve an ideal projection surface on the tabletop and neutralise the wood structure.

We attached thin felt pads between the monitor and the tabletop to prevent the tabletop from damaging the monitor.

To bring the entire structure to a comfortable height, we simply placed it on a table. Since we wanted to create as neat an appearance as possible, we attached a black cloth to the underside of the round tabletop to hide the entire substructure and table frame.

In order to register when the tangibles were lifted and placed down, we had to install reed contacts in the tabletop. These are switches that can be activated through the tabletop using a magnet. However, our goal was not only for the tangibles to trigger the contacts, but also for them to click into place noticeably in the corresponding positions.

At the beginning, we experimented with several magnets and steel rings. However, this resulted in the problem that the tangibles very often snapped into the wrong position and thus did not reliably trigger the reed contact.



Technical setup of the tangible and magnet sensors

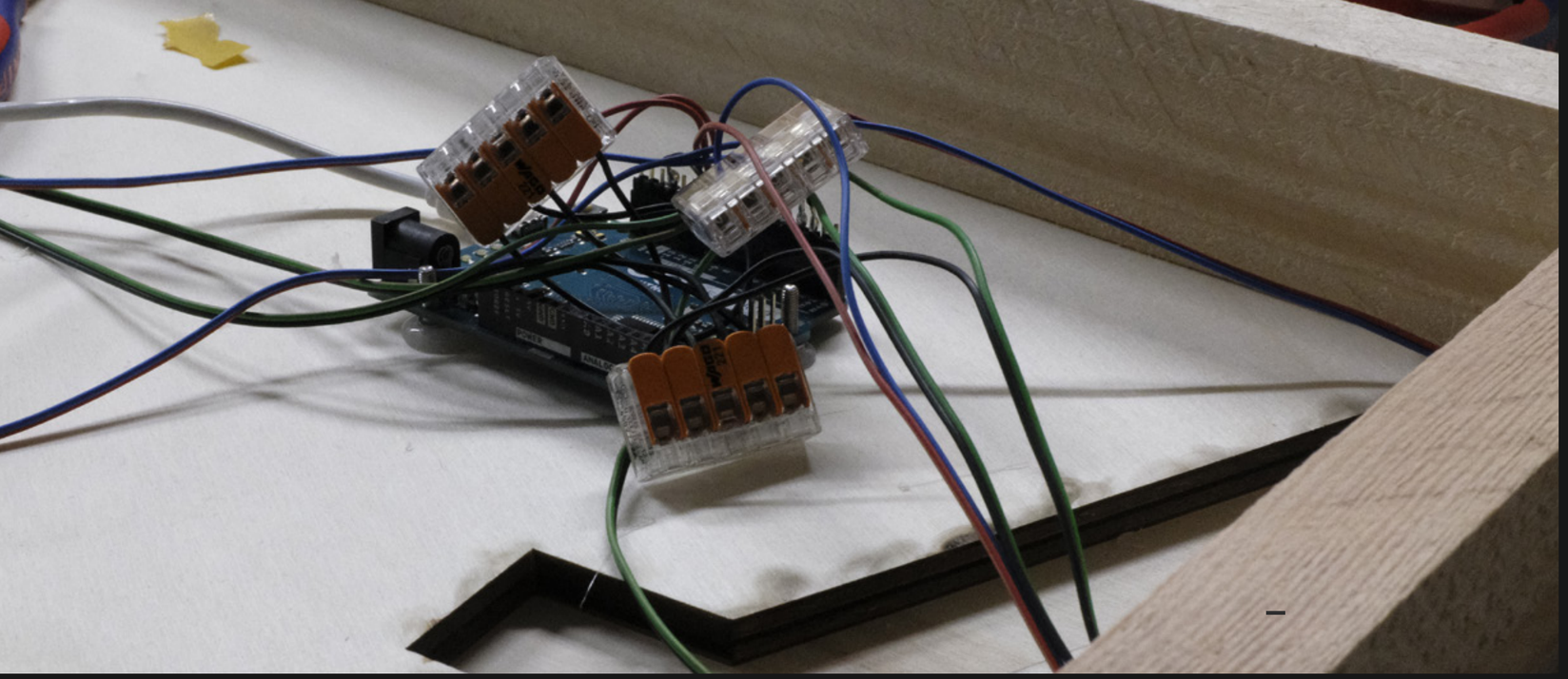
We then developed a new concept. Each tangible contains only two magnets: a small positioning magnet at the bottom and a significantly wider trigger magnet directly above it. In the second layer under the table surface, we installed 3D-printed holders. Each of these holders contains a central positioning magnet and a reed contact, which is placed at a very precise distance. This distance is chosen so that the holder‘s own magnet does not yet trigger the contact.

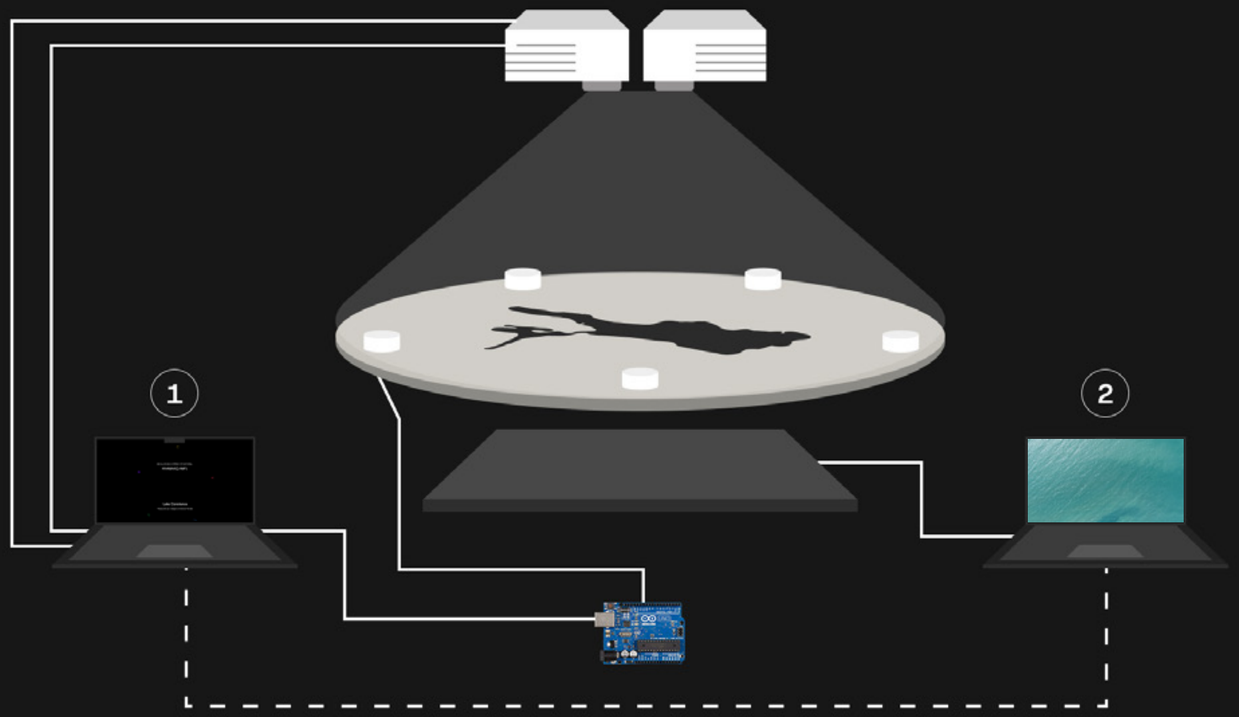
When a user places a tangible on the table, the small magnets attract each other so that the object snaps perfectly into the intended position. Since the second magnet in the tangible is significantly wider, it’s magnetic field is strong enough to reach the reed contact and activate the sensor. This simple but effective system transmits precise information to the software about where each tangible is located and starts the corresponding animations.

To ensure that the reed contact triggers cleanly every time, we repeatedly changed the positioning within the 3D-printed holder in several iterations and tested how reliably the contact triggers.



Tangible 3D Modelling

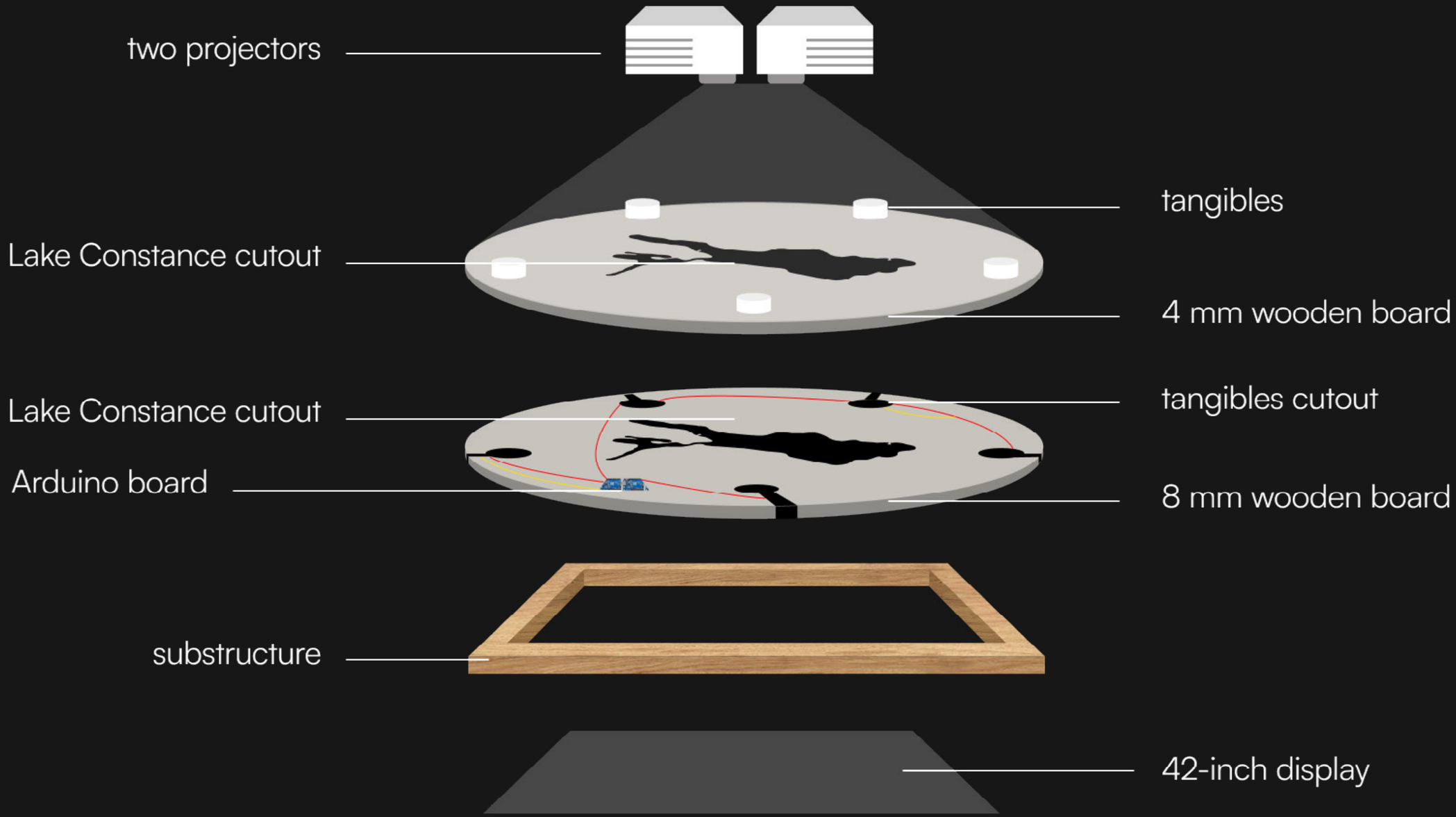




System architecture showing the real-time synchronization of hardware and visual outputs via a wireless WebSocket connection

WebApp
All reed contacts are connected to an Arduino. This detects the physical impulses and forwards them as key commands to the master MacBook. On this master laptop, projection mapping software manages the visual output for the two projectors on the tabletop. The technical capacity of the master MacBook is limited to two external monitors. That's why another MacBook controls the central screen and receives the signals wirelessly via a web socket.

The web socket serves as a bridge between the main computer and the second MacBook, enabling real-time data exchange. It provides a connection between multiple devices on the same network. When the Arduino registers the placement of the tangibles on the table, the master MacBook forwards this input to the receiver in the network via a self-programmed web app and the web socket. The second monitor then displays the corresponding visual on the lake display.



Exploded view of the layered hardware construction and table assembly









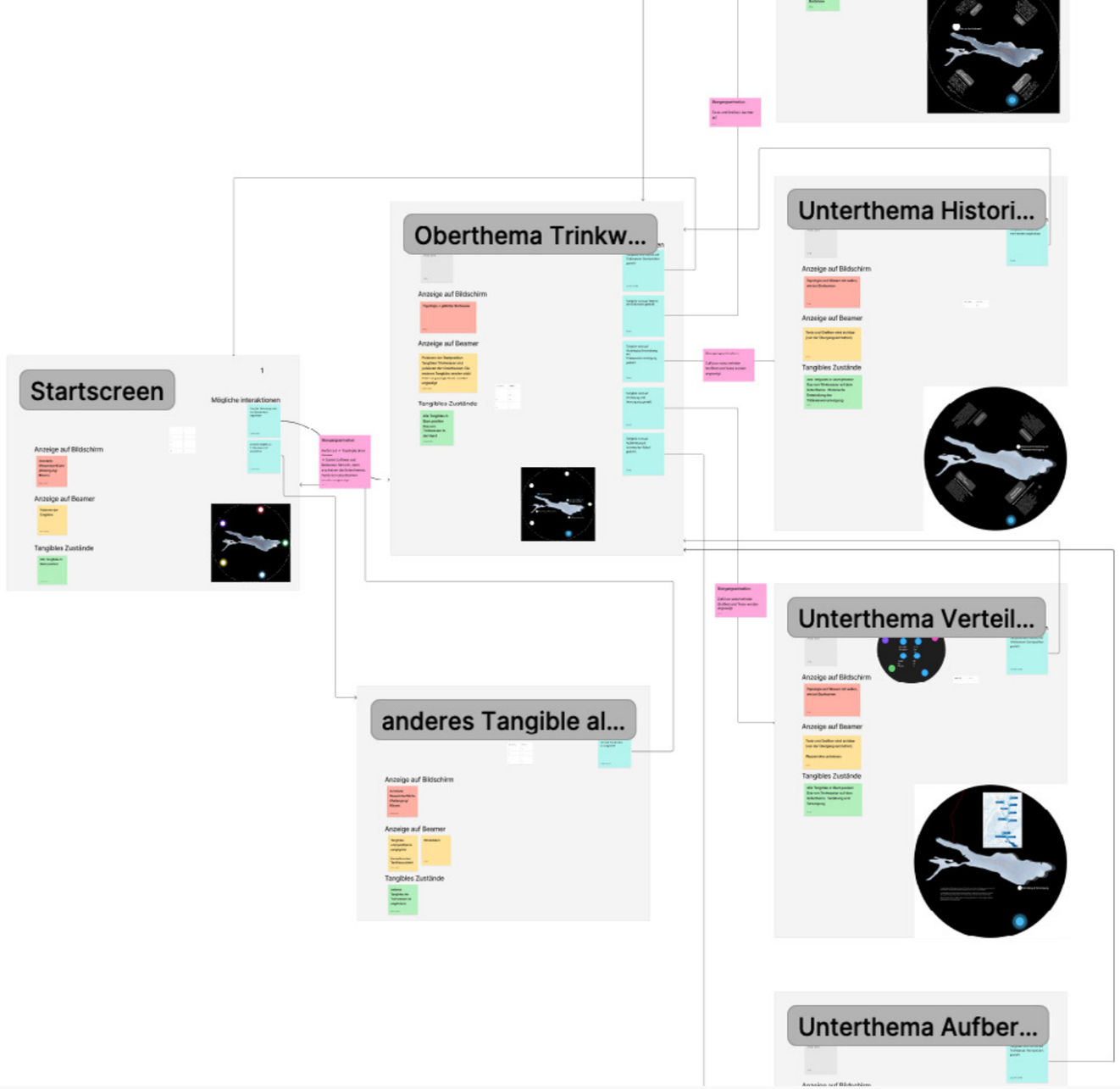
User-Flow

User-Flow

We defined the user flow and the associated state changes to enable programming of the system. The system is based on querying the Reed contacts, whereby each interaction (lifting or placing down the tangibles) triggers a change in the interface.

The process begins on a start screen, where the user selects a main topic by lifting the corresponding tangible. Immediately after lifting, an initial transition animation is triggered. Once this is complete, the system displays the selection screen for the subtopics.

The possible positions where the user can place the tangible back down are now projected directly onto the tabletop. As soon as the user places the tangible object on one of these marked positions, the screen with the corresponding content starts after another transition animation. If the tangible object is lifted again, the system jumps back to the selection of subtopics within the current category.



Screen 1

Tasten Schlag	Screen zu:
1	3
2	3
3	3
4	3
5	2

Screen 2

Tasten Schlag	Screen zu:
e	1
j	4
h	5
i	6
g	7

Screen 3

Tasten Schlag	Screen zu:
a	1
b	1
c	1
d	1

Screen 4

Tasten Schlag	Screen zu:
0	2

Screen 5

Tasten Schlag	Screen zu:
8	2

Screen 6

Tasten Schlag	Screen zu:
9	2

Screen 7

Tasten Schlag	Screen zu:
7	2



Here, the user can either select another subtopic by moving the tangible to one of the other positions, or they can return the tangible to its original starting position to leave the top-level category and return to the start screen.

Tangibles that cannot be interacted with in their current state, for example because a specific subtopic is already active, are no longer highlighted with projections. This allows us to intuitively signal to the user which objects are currently functional.

In order to program this logic, we created a logic that precisely defines which switching of the reed contacts leads to which screen.

Interaction logic and UI feedback showing how moving physical tangibles triggers different subtopics and system states

Design System

Design System

Color Palette and Typography
To ensure that the content is the main focus, we chose a dark theme for the interface. A black background was essential to allow the colors of the lake and the projections to stand out vividly in the darkened exhibition room.

Each of the five core themes is assigned its own distinct highlight color. This color-coding acts as a visual guide, helping users to immediately recognize which theme they are currently exploring and making navigation through the data intuitive.

For the typography, we selected Satoshi Variable. We chose this font for its readability at various scales and its modern, clean aesthetic, which harmonizes perfectly with our graphical elements.



Satoshi Variable

Medium

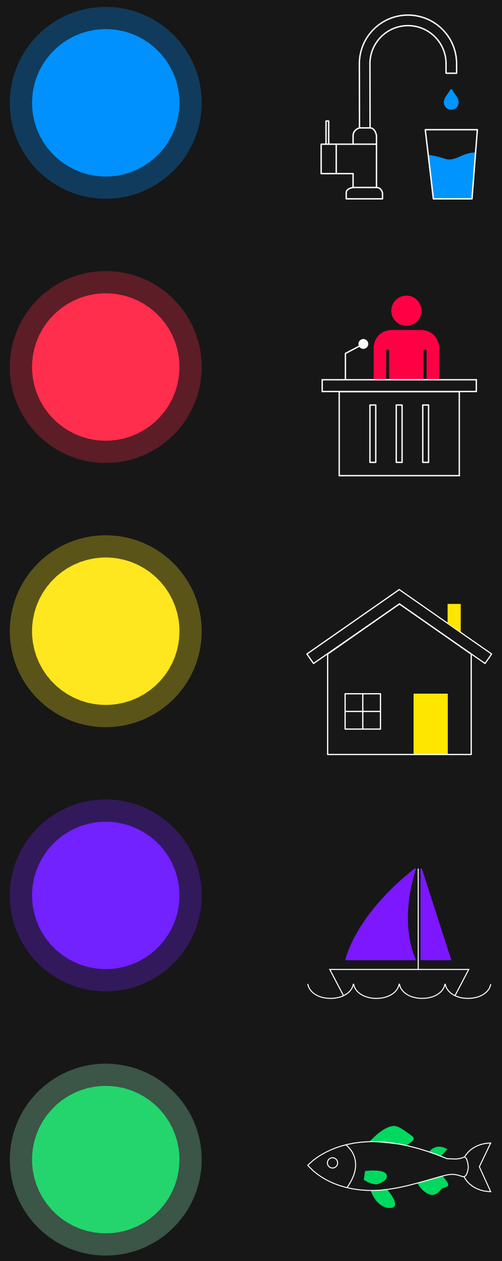
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Headline 2

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Visual design system and color coding for the five core themes

Graphics
Finding the right visual language was one of the more challenging parts of our process. Given the endless possibilities, we spent a lot of time researching inspiration and discussing different styles to find a look that the whole group identified with.

We eventually defined a style that is detailed and vibrant, yet maintains a professional balance that is neither too childish nor too technical. Our final visual language is based on detailed line art.

We used fine outlines to create clear and elegant illustrations that remain professional and easy to interpret. To provide visual structure, we applied the theme's specific highlight color to select areas of the graphics.

Animation
Animation plays a crucial role in making the system intuitive and responsive. To guide the user without the need for written instructions, the „drop zones" for the tangibles feature a subtle pulsing animation. This visual signals exactly where an interaction is expected.

The primary function of the animations is to provide immediate feedback: placing a tangible on a drop zone triggers specific animated sequences on the table.

This confirms that the system has recognized the input and brings the information to life, ensuring a natural and engaging flow throughout the experience.

Outlook

Looking back at our process, we see this prototype as just the beginning. While we have laid the groundwork, the next big step would be to fully develope all five main themes.

We want each topic to have the same depth and detail as our current modules to provide a truly complete experience of Lake Constance. We also see a lot of exciting potential in how the lake display and the table projection work together. In the future, we would love to connect these two even more, making animations flow more naturally from the display onto the table surface.

Imagine water ripples or weather effects that start in the center of the lake and spread across the entire installation.

For us, the ultimate goal is to make the transition between the digital screen and the physical table feel even more seamless and alive.





WE ♡
BODENSEE

29.01.2026

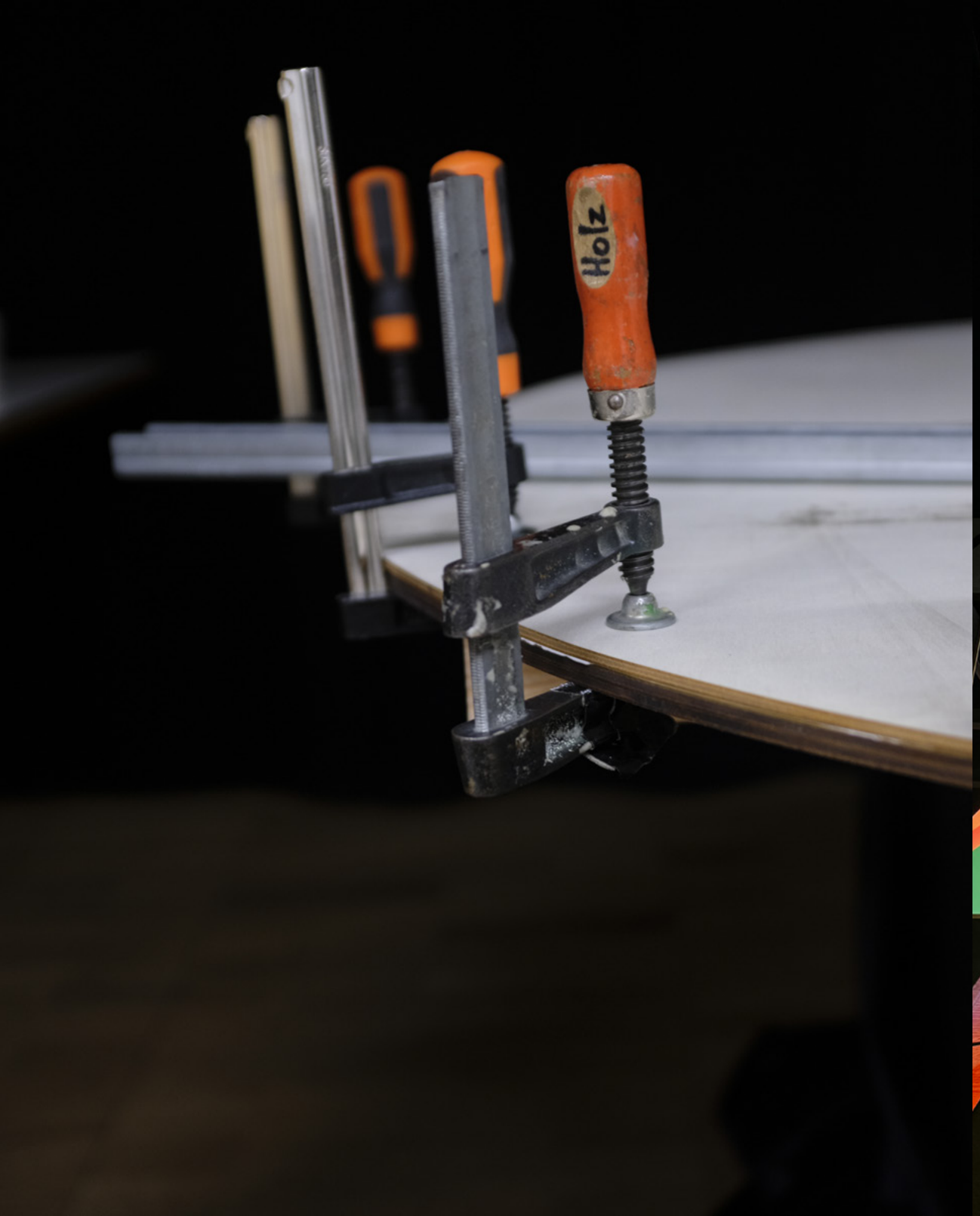
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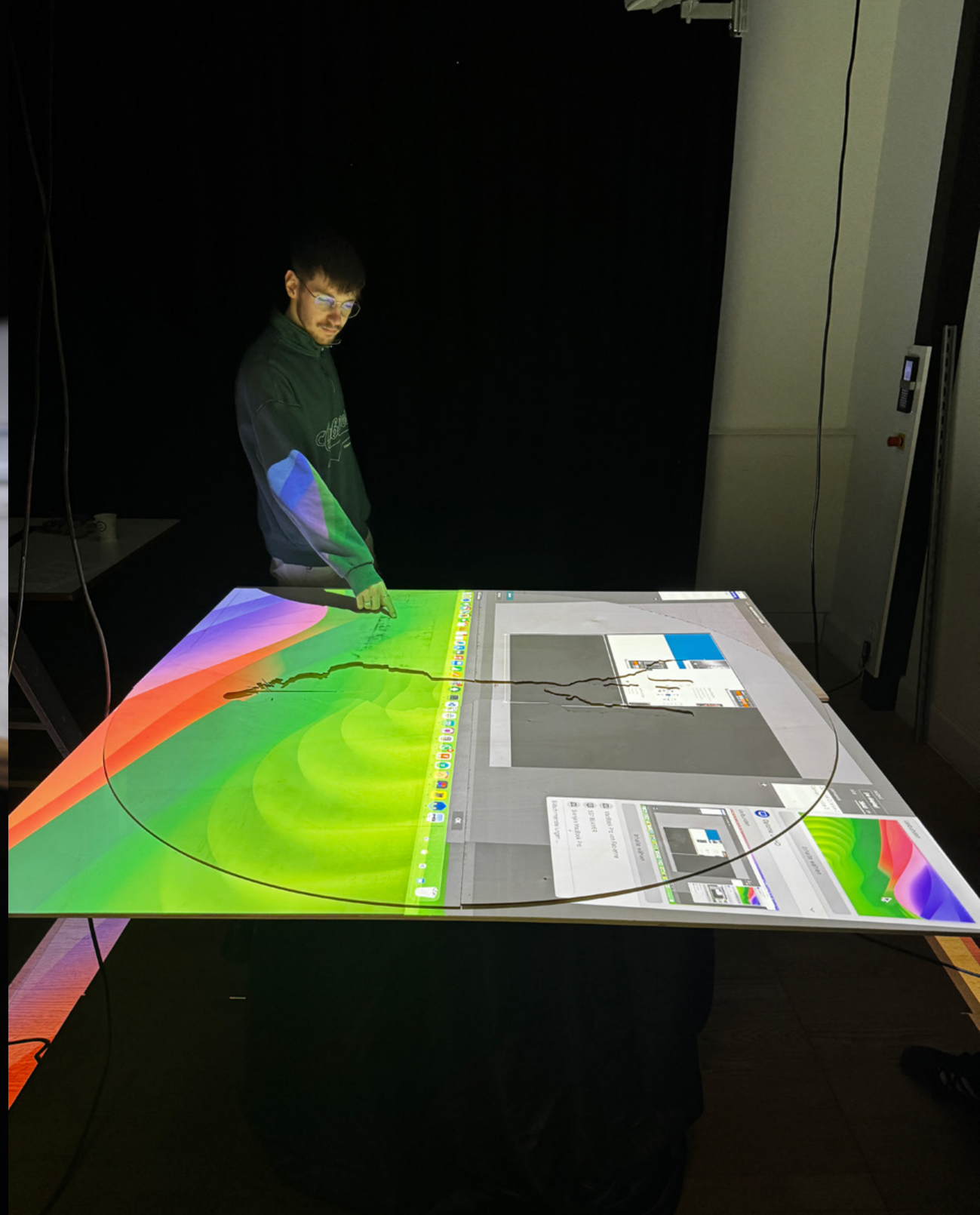
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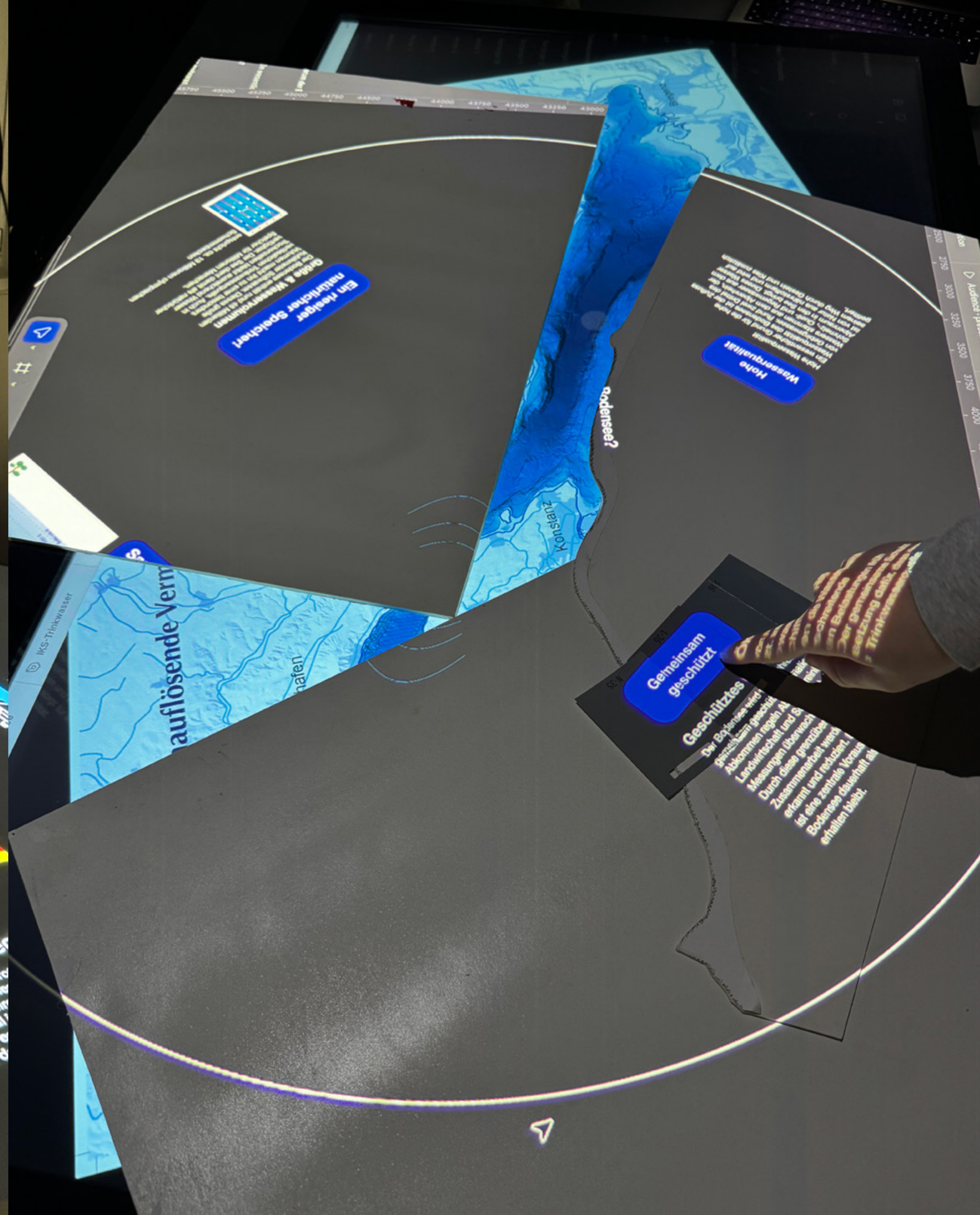
Luzion

Tobi


Holz




Water from the Alps
A Shared Proter
Lake Constance is jointly pro
Switzerland. Common rule
shipping across the entir
identify environmental
shared approach is e
reliable source of d


Ein flexibler Spielfeld-Rahmen
Gemeinsam geschützt
Geschützt





Lake Constance - an interactive exhibition

HfG Schwäbisch Gmünd
IG2 Interactive Communication Systems
Documentation

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