

Designing Interfaces for Elastic Displays Using Workshop and Prototyping Methods

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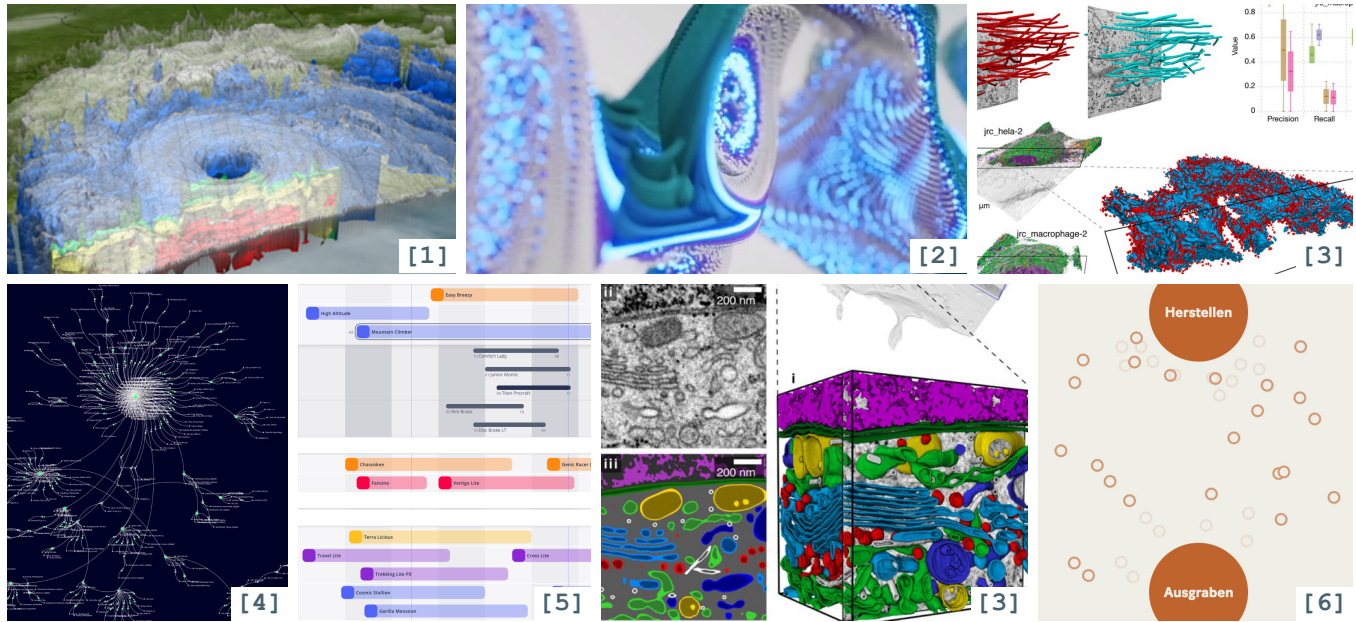


Figure 1: Moodboard with inspirational material of existing data visualization interfaces used for specifying the concrete application domain in the preparation phase. [1],[2],[3],[4],[5],[6]

ABSTRACT

Any design endeavor requires practitioners to engage in divergent thinking (cp. Double Diamond Model). Numerous creativity techniques and methods exist to support the design process and give structure in order to converge a wide variety of ideas into suitable candidates for prototyping and testing. Designing for specific, tangible interaction technologies requires a careful framing of the selected methods.

Over the course of 10 years, our research group has gained experience in designing and developing applications for elastic displays. In this pictorial paper, we illustrate methods and intermediate results for a concrete application design. Due to the Covid19 pandemic, we made extensive use of the collaborative whiteboard application

miro. We designed a way to visualize, explore, and evaluate clustering algorithms in the domain of machine learning using an elastic display. Finally, we present follow-up techniques for prototyping the concepts and ideas.

CCS CONCEPTS

• **Human-centered computing** → *Interaction design process and methods; HCI theory, concepts and models.*

KEYWORDS

elastic display, interaction design, design methodology, design thinking, user centered design

1 PREPARATION: CREATING A SCHEDULE

Our design process was part of a research project between a company and a University of Applied Sciences. The goal was to involve as many experts from design and software development as possible to yield the best ideas. However, we found it very beneficial to alternate between the number of participants. Workshops with more than three participants produced many intermediate results that were condensed by fewer colleagues afterwards as input for

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Figure 2: Categorized and grouped ideas resulting from the “Crazy 8” method used in Workshop I.

With interest	Students	Data Scientist	Designer	User
Readers of the "Atlas of Globalisation" People who want to understand what is behind the buzzwords AI and data analytics Fair visitors looking for give aways	Data Science Student	Data Scientist Bioinformatician Computer scientist who wants to understand clustering algorithms Mathematician who wants to investigate strengths / weaknesses of the individual algorithms	Adobe-Evangelist Designer who likes to improve visualisation & interaction may improve Controlling	Physician Biologist Meteorologist Physicist / Astronomer Chemist Sociologist or similar. (Cluster = Social Data) Quality Engineer Mathematician
Museum visitors - acquiring overview knowledge	Student - learn application	Someone who works with the algorithms and knows exactly how they work.	Designer -Understanding of how things work	Someone who wants to work with the processed data

Figure 3: User segments created in Workshop II.

the next extensive workshop. Due to organizational issues such as limited time resources and remote work, each workshop was restrained to a duration of max 2 hours. The process shown in this pictorial paper spanned approximately two months. Two persons were responsible for preparing the schedule and initial contents required for the workshops.

Initially, the subject area was roughly characterized as “Big Data Exploration”. An important first step was to boil down the scope and prepare precise questions. As a result, the application domain was specified and necessary details for a basic understanding were researched. The preparing team also provided some initial inspirations (see 1) and presented different existing solutions on traditional user interfaces. The idea was to point at specific issues that could be solved by leveraging the possibilities of the elastic display. All material was collected in a miro¹ virtual whiteboard.

2 WORKSHOP I: BROADENING THE VIEW

The first workshop had seven participants and the main focus was to foster divergent thinking according to the double diamond model [7],[8]. The input from the preparation phase included information on the topic and the technological setup of the elastic display. The application domain of clustering algorithms was opened up,

considering different possible applications, visualizations, and interactions. For the initial question: “How to handle clustered data from machine learning on the elastic display?”, each participant produced textual and sketched ideas according to the “Crazy 8” method [9] on the miro whiteboard (see 2). After the workshop, the manifold ideas of this workshop were grouped and categorized into the aspects of: navigation, animation, data selection, visualization, and filtering. These cleaned up outcome served as input for the next workshop.

3 WORKSHOP II: GETTING A GRASP ON USERS

In the second virtual workshop using the Miro whiteboard, a focus group of three participants converged the ideas and analysed user segments (see 3). This workshop also included a brainstorming phase based on the prior results. Again, the focus was broadened in a first step by collecting inspirational material for possible user groups (see 4).

In the second step, the ideas were condensed into three suitable user groups covering a variety of aspects from the original user segments: meteorologists, medical experts, and biologists. Personas for these user groups were completed individually by the three workshop participants as follow-up work after the workshop (see 5).

¹<https://miro.com>

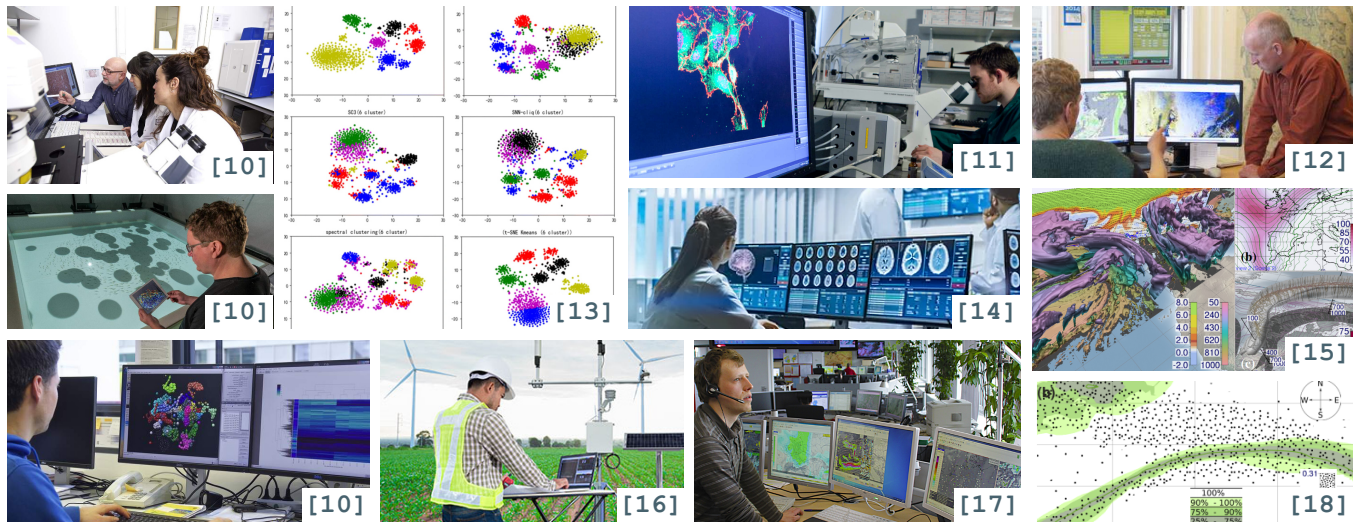


Figure 4: Collecting inspirational material for specifying user groups. [10], [11], [12], [13], [14], [15], [16], [17], [18]

Hintergrund Robert hat sich nach seinem Studium und der Promotion als Biologe selbstständig gemacht. Als Einzelkämpfer hat er sich ein Netzwerk an Projektpartnern aufgebaut, mit denen er regelmäßig in Kontakt steht. Er ist von der Komplexität des Lebens auf Erden fasziniert. Herausfordernde Probleme an denen man hartnäckig arbeiten kann, machen ihm besonders viel Freude. Sein Aufgabenfeld ist vielfältig und er hat Aufträge von verschiedenen Firmen. Sein Tag beginnt meist mit einer guten Tasse frischen Kaffee. Danach geht er ins Labor und prüft die einzelnen Proben und dokumentiert entsprechende Veränderungen. Häufiglich verfasst er Berichte und Empfehlungen an seine Auftraggeber. Der Nachmittag gestaltet sich abwechslungsreicher. Robert untersucht eventuell weitere Proben unter dem Mikroskop und dokumentiert sie. Oder er führt Nachbewertungen durch. Er ist sein eigener Boss und nimmt eine beratende Rolle im Netzwerk und gegenüber seinen Auftraggebern ein. "The questions and kinds of data are constantly changing, and get more challenging" Ziele • Übersicht über die ermittelten Daten gewinnen • sein Wissenshorizont erweitern Ängste • die Untersuchung führt zu keinem sinnvollen Ergebnis • die Daten wurden falsch interpretiert • nicht ausreichende Beratung beim Kunden durch eine Fehlinterpretation der Daten Wünsche • Überblick gewinnen • Unterstützung bei der Suche nach dem Ergebnis • Eintauchen in die gesammelten Daten • Ergebnisse der Experimente zielgerichtet untersuchen / analysieren Bedürfnisse • Zusammenhänge in den Daten finden • Allgemeines Verständnis schaffen Datenqualität und -komplexität: 4 • viele Dimensionen • hochwertig und verifiziert • vernetzte Daten • es gibt viel Deutungsraum? Daten- und Domainwissen: 5 • vollumfängliche Vorkenntnisse zu Visualisierungen • lange Berufspraxis Robert, 35 Biologie Researcher	Hintergrund Julia arbeitet seit dem Abschluss ihres Medizinstudiums als Angestellte an einer Uniklinik. Sie ist Fachärztin für Innere Medizin, Hämatologie und Onkologie. Jeder Tag gestaltet sich vielfältig. Neben der Behandlung der Patienten, erarbeitet sie Therapie- und Behandlungspläne, verfasst Berichte und wertet die erhobenen Patientendaten aus. In diesen vielfältigen Arbeitsfeld ist kein Tag wie der andere. Neben Besprechungen mit ihren Kollegen nimmt sie auch an Konferenzen teil und stellt ihre Publikationen vor. Bei ihrer Tätigkeit benötigt sie ein vielseitiges Wissen auf Biologie, Anatomie und Physik. Durch ihr Einfühlungsvermögen lieben sie die Patienten und fühlen sich bei ihr in guten Händen. Nach stressigen und psychisch anstrengenden Tagen liebt sie es mit ihren Freundinnen Yoga zum Ausgleich zu machen. "Eine fachübergreifende Zusammenarbeit ist der Schlüssel zum Erfolg" Ziele • erhobene Daten für die Behandlung der Patienten optimal auswerten • mehr Zeit für die Patienten haben • weniger Zeit am Computer verbringen Ängste • die aufgestellten Behandlungspläne führen nicht zum gewünschten Ergebnis • die erhobenen Daten sind zu unübersichtlich und werden nicht korrekt zugeordnet Wünsche • Überblick gewinnen • Übersichtliche Sortierung der Daten zum kunden • flexible Visualisierung um diverse Behandlungsmethoden durchspielen zu können • die gewonnenen Kenntnisse veröffentlichen und mit den Kollegen besprechen und diskutieren Bedürfnisse • Zusammenhänge in den Daten finden • Allgemeines Verständnis schaffen • optimale Strategien ermitteln • Diagnostik auf fundierte Daten stützen Datenqualität und -komplexität: 4 • viele Dimensionen • hochwertig und verifiziert • vernetzte Daten • es gibt viel Deutungsraum? Daten- und Domainwissen: 5 • vollumfängliche Vorkenntnisse zu Visualisierungen • extrovertiert, ehrgeizig, engagiert, motiviert Julia, 34 Oncology Researcher	Hintergrund Marius arbeitet in einer Festanstellung als Windparktechniker. Studiert hat er Meteorologie und Computational Science. Während seiner Tätigkeit konnte er viel Erfahrung im Bereich Windmessung und Ertragsprognose für Windparks sammeln. Die abwechslungsreichen Tätigkeiten machen ihm besonders viel Freude. Sein Aufgabenfeld ist vielfältig. Er arbeitet an Messstationen im Freien, überwacht und interpretiert die Live-Daten aus mehreren Quellen, erstellt Prognosen (Wettervorhersagen, Warnungen, Empfehlungen) und erstellt Datenanalysen, Modelle und Simulationen. Auf seinem Schreibtisch stehen sehr viele Monitore, mit denen er den Überblick behält. Weiterhin erstellt er auch Ökologische Gutachten und vermittelt diese an Kollegen. Kommunikation ist ein wichtiger Bestandteil seines Arbeitstags. Durch sein Studium ist er auch selbst in der Lage kleine Programmskizzen zu schreiben, besonders für die Datenanalyse und Modellierung. Das naturwissenschaftliche Mindset und logisches Denken erweitern seine Fähigkeiten. "Freundliches Betriebsklima ist das beste Klima" Ziele • Daten gut strukturiert aufarbeiten • Zeitersparnis • Qualitätssteigerung Ängste • nicht die richtigen Aussagen zu kommunizieren • dem Zeitdruck nicht gewachsen zu sein • sich nicht weiter zu entwickeln – Innovationsretarder Wünsche • Überblick gewinnen • Verständnis für die Daten erhöhen • Durchspielen und Begreifen vieler Varianten • Nachvollziehbarkeit der errechneten Prognosen • ersparte Zeit kann für die Verbesserung der Prognosemechanismen genutzt werden Bedürfnisse • Kollaboratives arbeiten fördern • Außenkommunikation verbessern – fortschrittliches Image transportieren • Prognosemodelle verbessern • Innovationen antreiben • ergebnisorientiertes Arbeiten Datenqualität und -komplexität: 5 • viele Dimensionen • hochwertig und verifiziert • zeitbezogene Daten (Vergangenheit, Zukunft, Wetter < Klima) • es gibt viel Deutungsraum? Daten- und Domainwissen: 4 • Angestellter Windparktechniker • zielorientiert, bodenständig, stressresistent, pragmatisch Marius, 46 Meteorology Researcher
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Figure 5: Personas for three user segments: meteorologists, medical experts, and biologists. [19], [20], [21]

Moreover, an initial story map was created as preparation for the third workshop.

4 WORKSHOP III: CREATING A STORY

With five participants, the categorized ideas and the user requirements identified in the previous workshops were collected in a story map on the Miro whiteboard containing an "enter", "exploring", and "leaving" phase (see 3).

We considered the pain points of our personas in regard of the tasks from the different associated disciplines: biology, medicine,

and meteorology. Our story map also served to prioritize functions in order to define a minimal viable product (MVP), keeping additional ideas in a separate lane as future extensions (see 6).

5 WORKSHOP IV: DEFINE THE INTERACTIONS

The fourth workshop with three participants was devoted to brainstorming the interaction concept necessary to realize the functionality defined in the story map. This workshop was performed at an actual elastic display in a table setup with the goal to identify intuitive interaction metaphors. An important issue was to find out discrepancies, redundancies, and conflicts in the proposed gesture

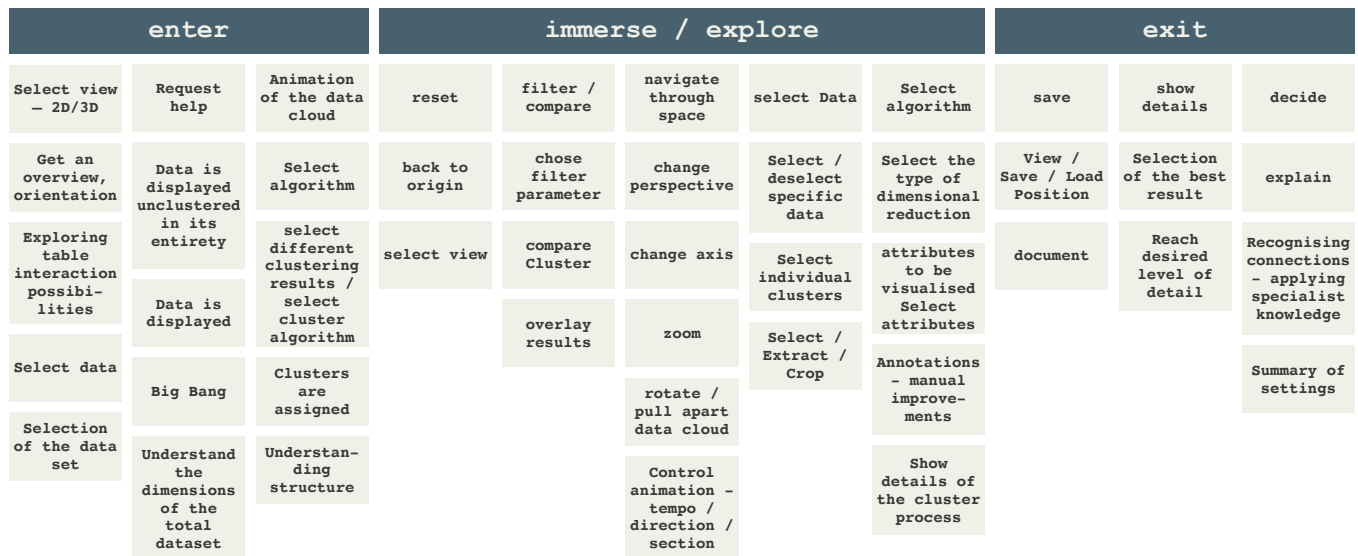


Figure 6: User Journey containing categorized user requirements as input for Workshop III.

Story Map – analysing Datacloud

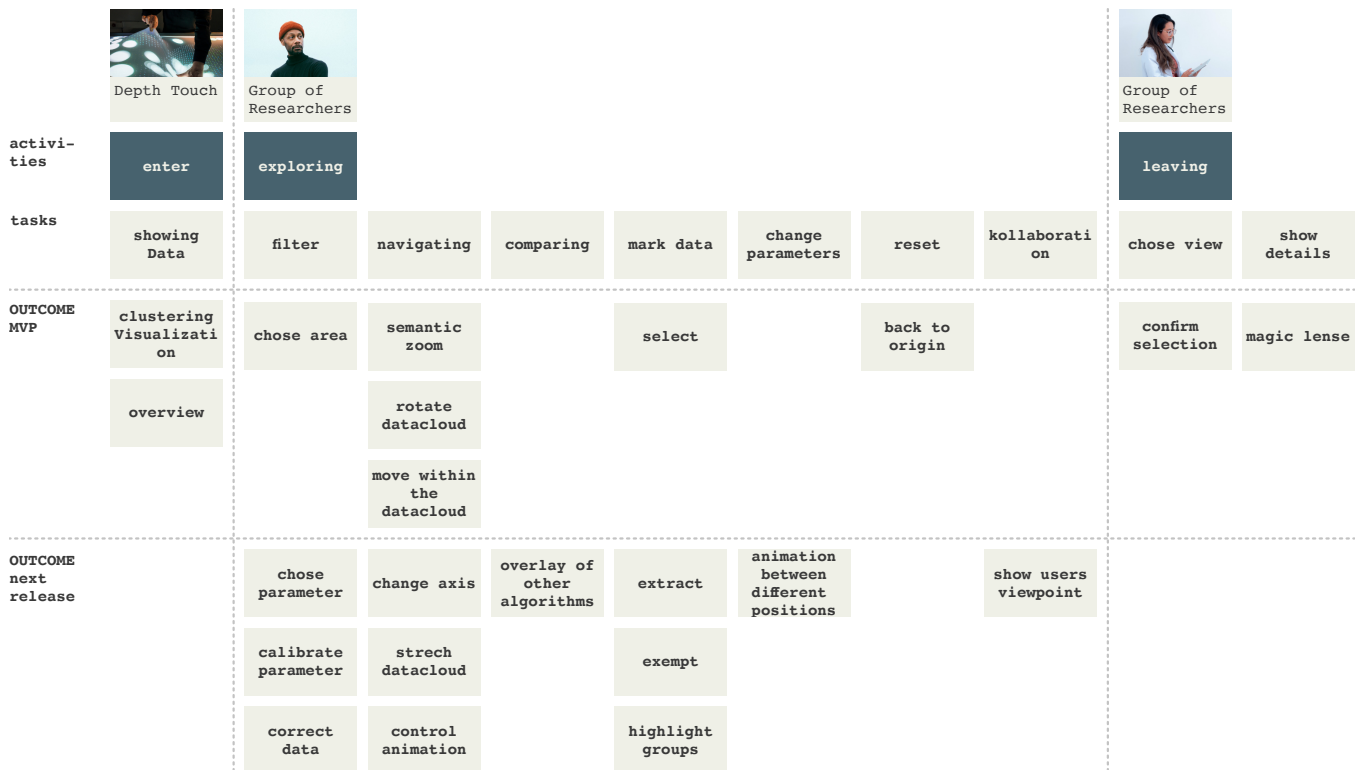


Figure 7: Resulting Story Map containing the MVP-feature set, grouped into the user requirement categories and extended features as additional lane on the bottom.

set. In order to document the results for all team members in the miro whiteboard, stop motion videos were produced. Two persons

were responsible for the consolidation of the ideas. Gestures were

gesture	stop motion movie	H/F	var1	var2	var3
Move Datacloud     		2	×		
		1			
		1		×	
		1			
		1	×		×
					
Rotate Datacloud    		2	×		×
		2			
		2		×	
		2		×	
					
Select Area    		2			
		4	×	×	
		1			×
		1	×	×	
					
Semantic Zoom    		2	×		×
		1		×	
		1			
		1			
Magic Lens   interactive corner		2			
		2			
		1	×	×	×
Reset   		2			
		1	×		×
		1		×	
Save  interactive corner		4			
		1			

Figure 8: Three different gesture sets for elastic displays covering the function defined in the user story map.

named and grouped and possible technological issues were identified. Conflicts and ambiguities were checked and gesture sets and variants were specified in order to eliminate the necessity of mode changes where possible. As a result, a gesture matrix including three possible versions of the interaction concept was created for further prototyping and testing (see 8).

6 PROTOTYPING: CONTINUE THE WORK

For more detailed prototyping, project members can individually refine the interaction concept even without permanent access to an actual elastic display (e.g. due to remote work). Such a mock up still provides a feeling for elasticity, handling, and the interaction possibilities of an elastic display. A plain wool fabric can be simply fixed to a picture or other wooden frame (see 9). As shown in the fourth workshop, the stop motion technique can document interactions, even using other lo-fi elements such as cutouts.

Another prototyping method that we tested was the virtual reconstruction of an elastic display. This can be used to simulate and experience the actual use of an elastic display in a certain work situation (see 10). The restrictions imposed by the current tracking hardware and mechanical setup can avoid making mistakes such as using areas near to the edge of the elastic display, which cannot be depressed as well as in the middle.

Finally, we are also working on a gesture recorder and emulator to be used in later interface design steps to converge the ideas from our design workshops into feasible solutions.

7 REFLECTIONS

In this pictorial, we presented a structured overview of a workshop-based approach for the development of user interaction methods for elastics displays. This approach was illustrated by an application to visualize, explore, and evaluate big data clusters. From grouping ideas in a first workshop using a creative ideation method (Crazy 8), we identified user segments and personas in a follow-up workshop. Based on this user research, a user journey, a story map, and finally concrete interaction methods were prototyped in the last two workshops.

We especially addressed the careful documentation of all design steps, which was achieved using the collaborative whiteboard application Miro due to the corona pandemic. In our experience, this documentation presents a great challenge and needs considerable resources. However, the wealth of different and new ideas from



Figure 9: Physical mockup for testing gestures on an elastic display and produce stop motion sequences for visualizing gestures and interface elements.

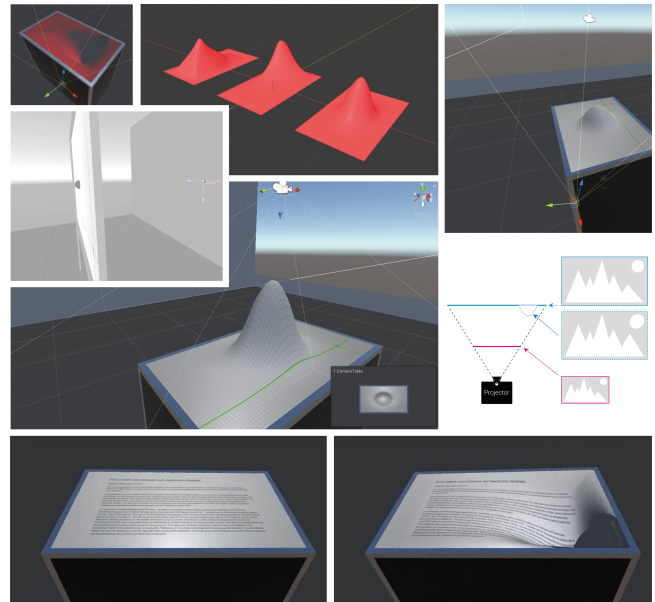


Figure 10: Experimental environment to analyse behaviour of Elastic Displays, especially in regard to projection and readability issues.

the workshops allows for a careful selection of the best solutions. Although this user-centered design process is not entirely new, our pictorial provides a clear example for novel interfaces based on elastic displays. We are confident that our approach is suitable for future interaction technologies such as other shape-changing interfaces.

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